

ICC 1300-202X

**Vulnerability-Based Seismic Assessment and Retrofit
of One- and Two-Family Dwellings**

American National Standard

International Code Council
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FOREWORD

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Introduction

In 2020, upon direction from the International Code Council (ICC) Board of Directors, the ICC Standards Council appointed a consensus committee to write a standard for the residential seismic assessment and retrofit of one- and two-family dwellings. The scope of the standard was to specify methods to provide residential seismic assessment and retrofit. The committee direction included development of ICC 1300 -202x, *Standard for the Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings*. The development of the standard will be initiated with FEMA P-1100, a prestandard, as an initial draft.

Development

This is the first edition of ICC 1300, *Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings*. This standard was developed by the ICC Consensus Committee on Residential Seismic Assessment & Retrofit Standard Consensus Committee (IS-RSARC) that operates under ANSI Approved ICC Consensus Procedures for the Development of ICC Standards. The consensus process of ICC for promulgating standards is accredited by ANSI. The IS-RSARC Committee is a balanced committee formed and operated in accordance with ICC rules and procedures.

The meetings of the IS-RSARC Committee were open to the public and interested individuals and organizations from across the country participated. The technical content of currently published documents on residential seismic assessment and retrofit, including the prestandard FEMA P-1100 which provided the starting point for the document development, was reviewed and considered by the committee. The information from these documents helped form a basis for the regulations provided in ICC 1300, but the exact provisions adopted by the committee were determined based on the scope and intent of ICC 1300. The requirements of ICC 1300 are based on the intent to establish provisions consistent with the scope of the ICC family of codes and standards that are written to adequately protect public health, safety and welfare; provisions that do not necessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

Adoption

ICC 1300, *Vulnerability-Based Seismic Assessment and Retrofit on One- and Two-Family Dwellings*, is available for adoption and use by any jurisdiction. Its use within a governmental jurisdiction is intended to be accomplished through adoption by reference in accordance with proceedings establishing the jurisdiction's laws.

Interpretations

Requests for interpretations on the provisions of ICC 1300-202x should be addressed to: International Code Council, Central Regional Office, 4051 Flossmoor Road, Country Club Hills, IL 60478.

Maintenance – Submittal of Proposals

All ICC standards are revised as required by ANSI. Proposals for revising this edition are welcome. Please visit the ICC website at www.iccsafe.org for the official "Call for Proposals" announcement. A proposal form and instructions can also be downloaded from www.iccsafe.org.

ICC, its members and those participating in the development of ICC 1300-202x do not accept any liability resulting from compliance or noncompliance with the provisions of ICC 1300-202x. ICC does not have the power or authority to police or enforce compliance with the contents of this standard. Only the governmental body that enacts this standard into law has such authority.

International Code Council Consensus Committee on Residential Seismic Assessment & Retrofit Standard (IS-RSARC)

Consensus Committee Scope: The Consensus Committee (CC) on Residential Seismic Assessment & Retrofit Standard (IS-RSARC) shall have primary responsibility for minimum requirements to safeguard the public health, safety and general welfare through requirements for one- and two-family dwellings.

This standard was processed and approved for submittal to ANSI by the ICC Consensus Committee on Residential Seismic Assessment & Retrofit Standard Committee (IS-RSARC) approval of the standard does not necessarily imply that all committee members voted for its approval.

Representatives on the Consensus Committee are classified in one of nine voting interest categories. The committee has been formed to achieve consensus as required by ANSI Essential Requirements. At the time it approved this standard, the IS-RSARC Consensus Committee consisted of the following members:

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Category	Number
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Builder [B]	2
Standards Promulgator / Testing Laboratory [C]	2
User [D]	3
Utility [E]	0
Consumer [F]	0
Public Segment [G]	0
Government Regulator [H]	2
Insurance [I]	0
TOTAL	10

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- I. **Insurance:** Individuals assigned to the Insurance Interest category are those who represent the interests of an entity, including an association of such entities, that insure subject to the provisions or voluntarily utilize the provisions within the committee scope, including insurance related inspection agencies.

PREFACE

In 2013, the California Earthquake Authority and FEMA jointly funded a project with the Applied Technology Council to develop a “prestandard” for the seismic evaluation and retrofit of one- and two-family dwellings. The scope of the document is to identify and provide retrofit solutions for specific known vulnerabilities in wood light frame construction which is the most common type of dwelling in the United States. During the development process, ICC worked cooperatively on the project, providing input on the project, with a direction of taking the prestandard and converting it into an ICC Standard. The prestandard was completed in early 2019. The prestandard includes numerous prescriptive provisions, figures and pre-engineered drawings, as well as non-mandatory appendices and commentary.

ICC-1300 is a standard intended to provide a methodology for the identification, evaluation and retrofit of specific known vulnerabilities for one- and two-family wood light-frame residential buildings up to 2 stories in height located in Seismic Design Categories B through E. Also included is the evaluation and retrofit of masonry chimneys attached to 3 story buildings. The assessment and retrofit provisions include the use of the best available seismic numerical modeling tools and engineering practices to assist in development of assessment methods and to identify retrofit criteria to best achieve targeted performance objectives. Use of the provisions are anticipated to improve earthquake performance but is not intended to prevent earthquake damage.

This class of structure represents the most common type of dwelling in the United States. It is the goal that improved seismic design and seismic retrofitting of vulnerable configurations will increase the probability that homes are available to provide shelter following moderate to large seismic events.

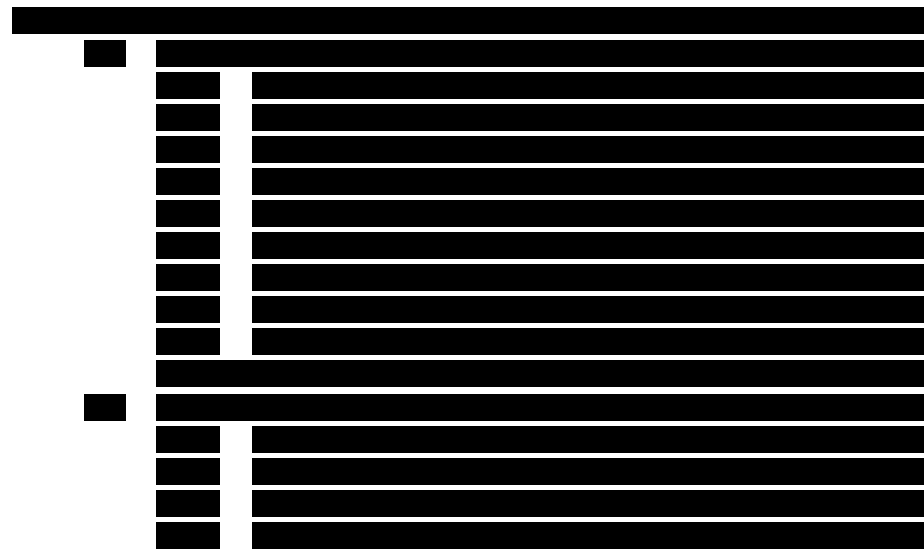
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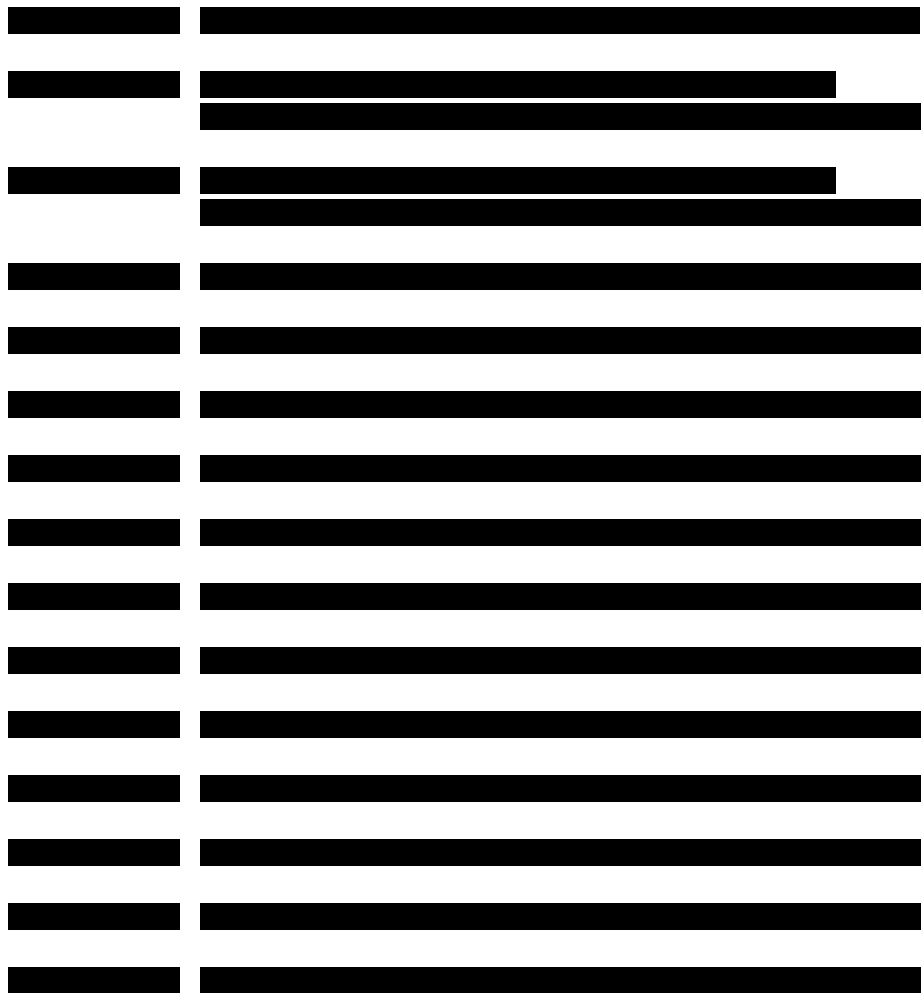
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Scope and Administration

1.1 Standard Scope

This Standard provides minimum criteria for vulnerability-based assessment and retrofit of seismic vulnerabilities in one- and two-family detached wood light-frame *dwelling*s. In addition to one- and two-family detached dwellings, this standard is applicable to *townhouses* and to single-family dwellings divided into multiple *dwelling units* since original construction, to the extent that the vulnerabilities and assessment and retrofit provisions are applicable.

The specific seismic vulnerabilities addressed by this standard are:

- *Crawlspace dwelling* anchorage to foundation, cripple wall bracing, and connection to the framed floor immediately above
- *Living-space-over-garage dwelling* ground story bracing
- *Hillside dwelling* anchorage to foundation and cripple wall bracing
- Brick masonry *chimneys*
- Anchorage of *masonry fireplace surrounds*

Where more than one of the above vulnerabilities occur in a dwelling, assessment and retrofit can address a single vulnerability or multiple vulnerabilities.

The assessment methods incorporated are:

- Simplified vulnerability-based assessment
- Detailed vulnerability-based assessment
- Engineered vulnerability-based assessment
- General engineered assessment

The retrofit methods incorporated are:

- Prescriptive vulnerability-based retrofit
- Simplified engineered vulnerability-based retrofit
- General engineered retrofit

General engineered assessment and retrofit methods are described in Section 1.7. Other assessment and retrofit methods are described in Chapters 4 through 7.

Compliance with this standard is achieved by demonstrating that existing conditions conform to the assessment provisions for an applicable vulnerability, or that non-conforming conditions are retrofit in accordance with the retrofit provisions for an applicable vulnerability.

1.2 Standard Purpose

The purpose of this standard is to promote public safety and welfare by reducing earthquake-induced damage to existing wood light-frame dwellings. The seismic assessment and retrofit provisions of this standard provide a methodology to identify and retrofit specific known vulnerabilities in wood light-frame dwellings. Use of the provisions of this standard is anticipated to improve earthquake performance but is not intended to prevent earthquake damage.

1.3 Alternative Methods

The provisions of this standard are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this standard, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be approved where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this standard, and the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in the adopted building or residential code in quality, strength, effectiveness, fire resistance, durability, and safety.

1.4 Use of This Standard

This standard is permitted to be used to assess and retrofit one or more vulnerabilities occurring in a dwelling. For each vulnerability to be retrofit, the applicable provisions of this standard shall be used as follows:

- The provisions of Chapter 1 and definitions of Chapter 2 shall be applicable to the assessment and retrofit of all vulnerabilities.
- The minimum construction provisions of Chapter 3 shall be applicable to all retrofits addressed by this standard.
- Crawlspace dwellings shall be assessed and retrofit in accordance with Chapter 4.

- Living-space-over-garage dwellings shall be assessed and retrofit in accordance with Chapter 5.
- Hillside dwellings shall be assessed and retrofit in accordance with Chapter 6.
- Masonry chimneys shall be assessed and retrofit in accordance with Chapter 7.
- Masonry fireplace surrounds shall be assessed and retrofit in accordance with Chapter 7.
- The detailed assessment checklists of Chapter 8 shall be used when required by Chapters 4 through 7.

1.4.1 Partial Retrofit

Retrofits that do not address all applicable locations or do not include all applicable retrofit elements for a specific vulnerability being addressed shall not be designated as conforming to this standard.

1.4.2 Phased Retrofit

Seismic retrofit is permitted to be phased. When phased construction is used, all *load-path connections* attaching the *retrofit element* into the dwelling shall be provided at the time of *retrofit element* installation. When phased construction is used, the dwelling shall not be designated as conforming to this standard until all retrofit construction is complete.

1.4.3 New Work

New work required but not addressed by this standard shall be in accordance with the adopted building or residential code.

1.5 Combinations of Seismic Vulnerabilities

Where more than one of the vulnerabilities addressed by this standard occur in a dwelling, assessment and retrofit can be of one, multiple, or all applicable vulnerabilities. It is not the intent of this standard to require that all potential vulnerabilities be assessed and retrofit.

When a dwelling is identified as complying with the provisions of this standard, the vulnerability or vulnerabilities that have been assessed or retrofit and found to conform shall be specifically identified. A dwelling shall only be designated as complying with this standard when all aspects and portions of the dwelling are assessed and, where required, retrofit to conform to the provisions of the chapter addressing that vulnerability.

1.6 Site Seismicity

The Seismic Design Category (SDC) of a dwelling shall be determined in accordance with ASCE/SEI 7 Chapter 11, *International Residential Code* (IRC) Section R301.2.2.1, or Figures 1.6-1 through 1.6-6 of this standard (reprinted from the IRC, presented at the end of this chapter). A dwelling thus assigned to SDC B through E is eligible for assessment and retrofit using this standard.

Engineered retrofit design shall be based on the short-period design spectral response acceleration parameter, S_{DS} , determined in accordance with ASCE/SEI 7. See Chapters 4 through 7 for design provisions.

Prescriptive retrofit designs are provided for S_{DS} values of 1.0, 1.2, and 1.5. The S_{DS} value applicable for seismic retrofit shall be determined based on the mapped SDC from Figures 1.6-1 through 1.6-6 or the web link <https://www.atcouncil.org/fema-p-1100> (last accessed June 29, 2018) and the following:

- For SDC B through D₁, S_{DS} shall be taken as 1.0
- For SDC D₂, S_{DS} shall be taken as 1.2
- SDC E, S_{DS} shall be taken as 1.5

Alternatively, S_{DS} shall be permitted to be determined in accordance with ASCE/SEI 7.

Where S_{DS} falls below 1.0 or between the values of 1.0, 1.2, and 1.5, the prescriptive retrofit design shall use the next higher S_{DS} value for which prescriptive designs are provided. Where S_{DS} falls above 1.5, the prescriptive design for 1.5 is permitted to be used. Interpolation of prescriptive retrofit provisions between S_{DS} levels is not permitted.

1.7 Assessment and Retrofit Methodologies

The methodologies for seismic assessment and retrofit are listed in Section 1.1. This section discusses use.

1.7.1 Assessment Methodologies

Assessment is performed to determine whether seismic retrofit is needed for compliance. Assessment shall be by one of the four methods identified in Section 1.1. Where vulnerability-based assessment is used, assessment scope is limited to the vulnerable elements and their load path connections to the dwelling, in accordance with applicable provisions of Chapters 4 through 7.

General engineered assessment scope shall include the entire dwelling *seismic force-resisting system*, and be in accordance with other approved code or standard provisions.

1.7.2 Retrofit Methodologies

Retrofit shall be by one of the three methods identified in Section 1.1. Where vulnerability-based retrofit is used, retrofit scope is limited to the vulnerable elements and their load path connections to the dwelling, in accordance with the applicable provisions of Chapters 4 through 7.

General engineered retrofit scope shall include the entire dwelling seismic force-resisting system, and be in accordance with other approved code or standard provisions supplemented by the following additional retrofit provisions:

- For retrofit of crawlspace dwellings and living-space-over-garage dwellings, the cripple wall or garage stories shall be recognized as a soft and weak story due to the reduced strength and stiffness of finish materials, and shall be identified as a vertical irregularity for purposes of seismic design. Unless otherwise accounted for in the retrofit design methodology, the cripple wall or garage story shall be designed for 1.5 times the seismic story shear force otherwise required.
- For retrofit of hillside dwellings, the base level diaphragm shall be idealized as rigid or modeled as semi-rigid, and the relative stiffness of vertical elements shall be considered in determining distribution of seismic forces and detailing of load path connections. Modeling shall include as a minimum the story (including finish materials) above the base level diaphragm as well as the bracing elements at and below the base level diaphragm.

1.8 Limitations of Use

Use of this standard is limited to dwellings that are compliant with all of the eligibility statements of Table 1.8-1. Where one or more statements are identified as non-compliant, general engineered assessment and retrofit methods, as described in Section 1.7.2, are required.

Table 1.8-1 Eligibility Criteria for Use of the standard

	Eligibility Criteria	Compliant	Non-Compliant
1	The dwelling is a detached <i>one- or two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> and assessment and retrofit will occur for each attached <i>townhouse unit (the full townhouse structure)</i> .		
2	The dwelling is of wood <i>light-frame construction</i> .		
3	The weight of the exterior wall finish does not exceed 10 psf, except that masonry veneer wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.		

1.9 Conditions Beyond the Scope of this Standard

This standard addresses the assessment and retrofit of seismic vulnerabilities identified in Section 1.1. Additional seismic vulnerabilities might exist, but are beyond the scope of this standard.

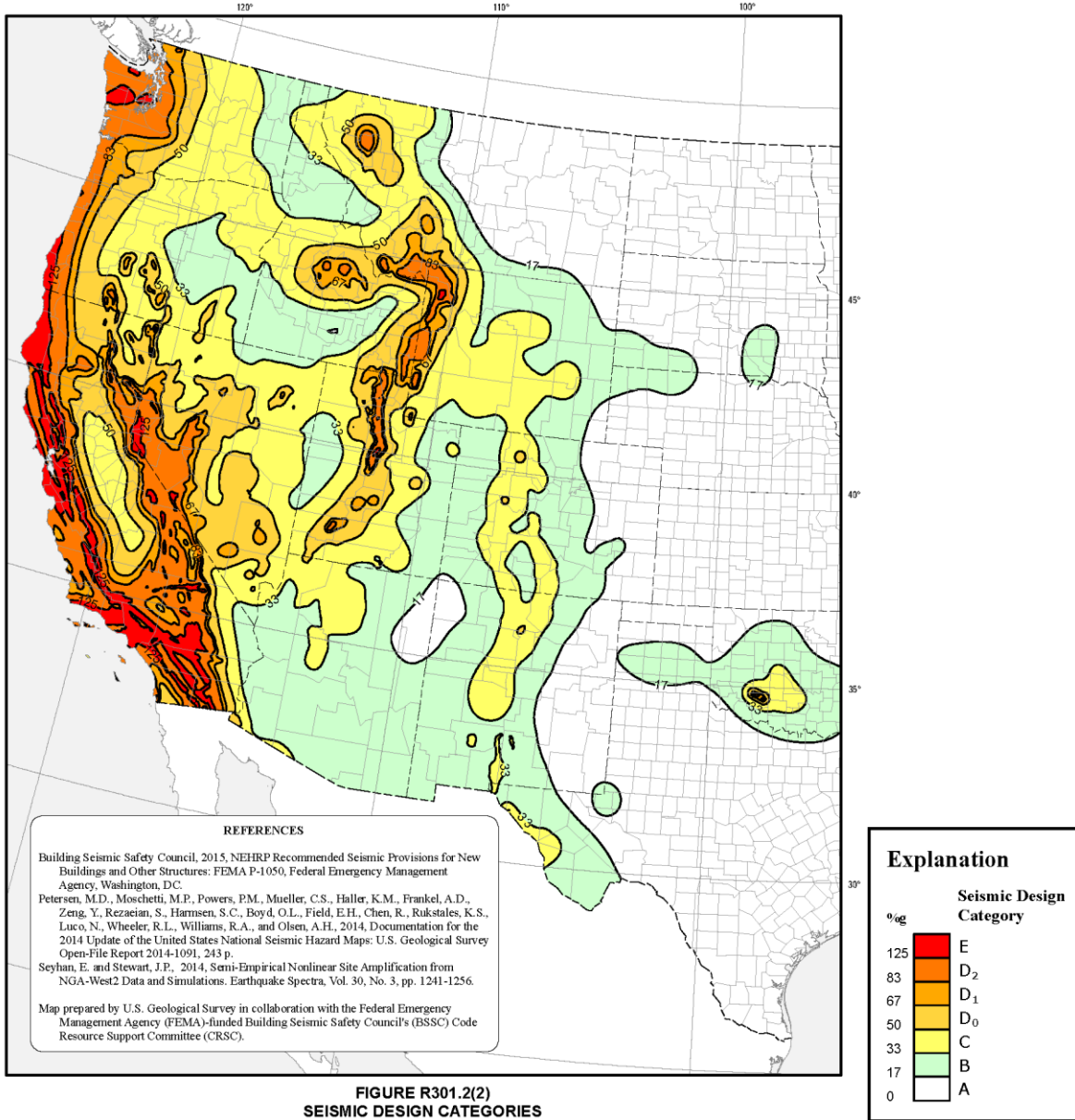
The vulnerability-based methods of this standard do not require assessment or mitigation of site soil hazards including but not limited to: liquefaction, landslide, surface fault rupture or densification. See non-mandatory Appendix S for descriptions of these hazards and seismic performance implications.

1.10 Administrative Provisions

The following administrative provisions shall apply in addition to the provisions of the adopted building or residential code:

Construction documents are required to be developed in enough detail to communicate the extent, locations, and details of retrofit work to be constructed in order to comply with this standard.

See Chapters 4 through 7 for inspection and verification of retrofit installation.



**FIGURE R301.2(2)
SEISMIC DESIGN CATEGORIES**

Figure 1.6-1 Seismic Design Category (SDC) map, western conterminous states (reprinted from the IRC).

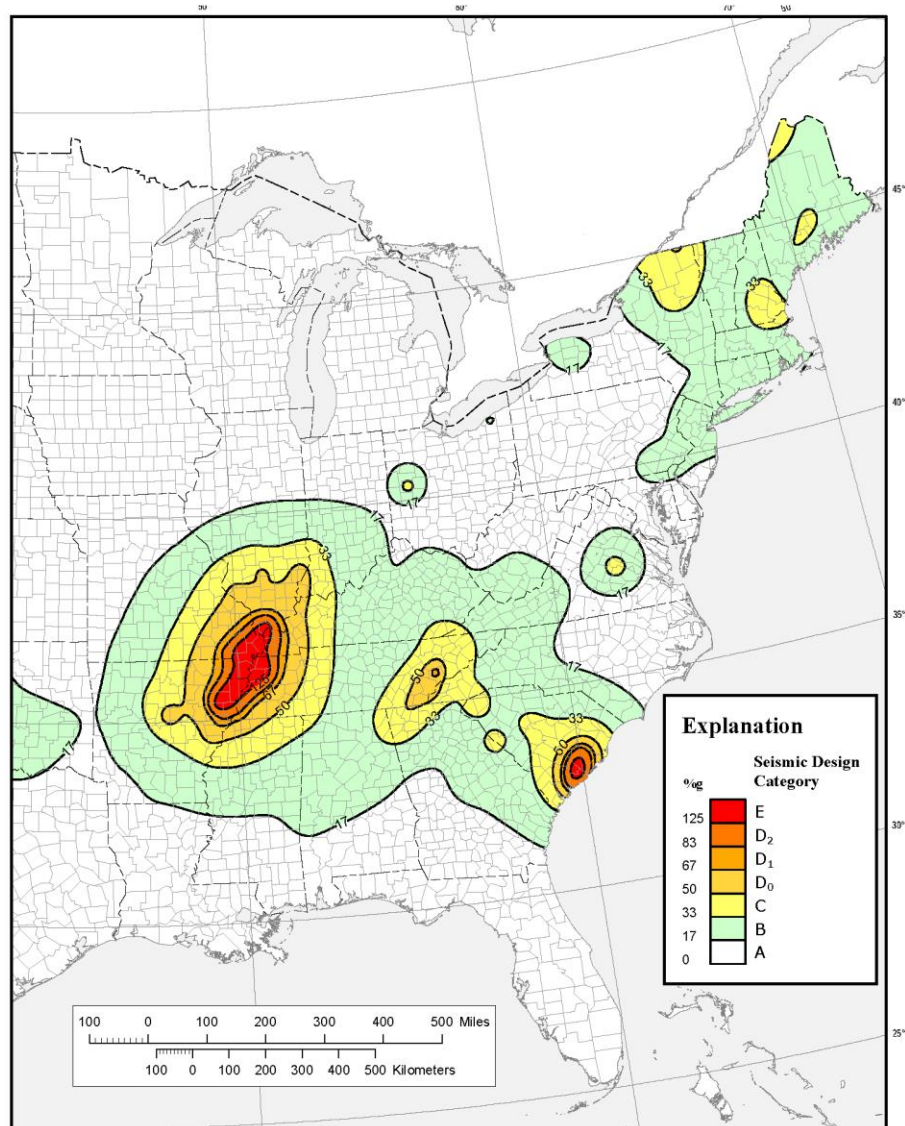
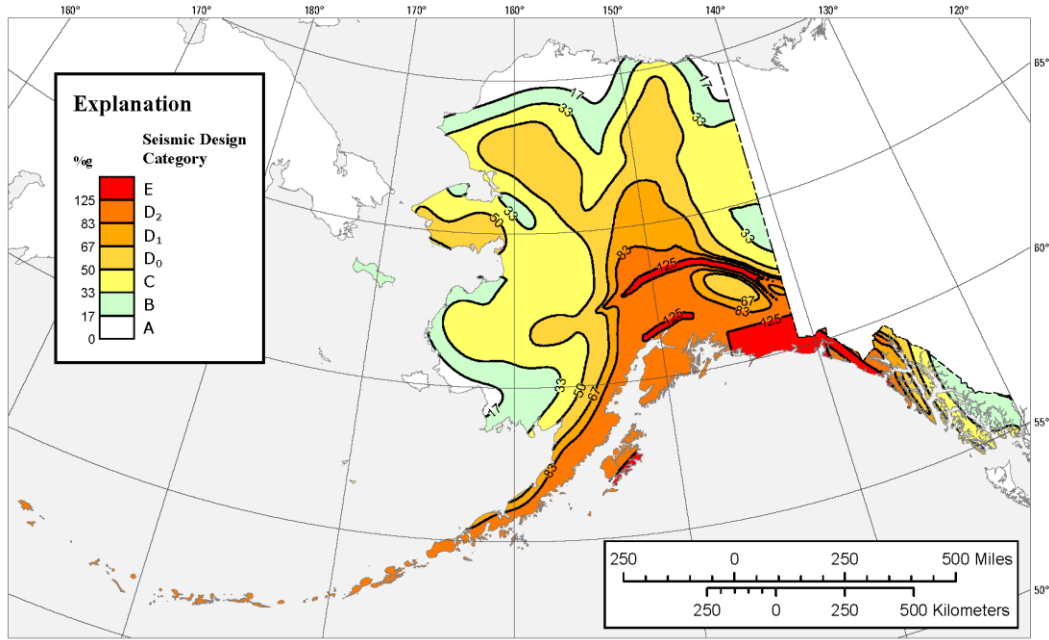


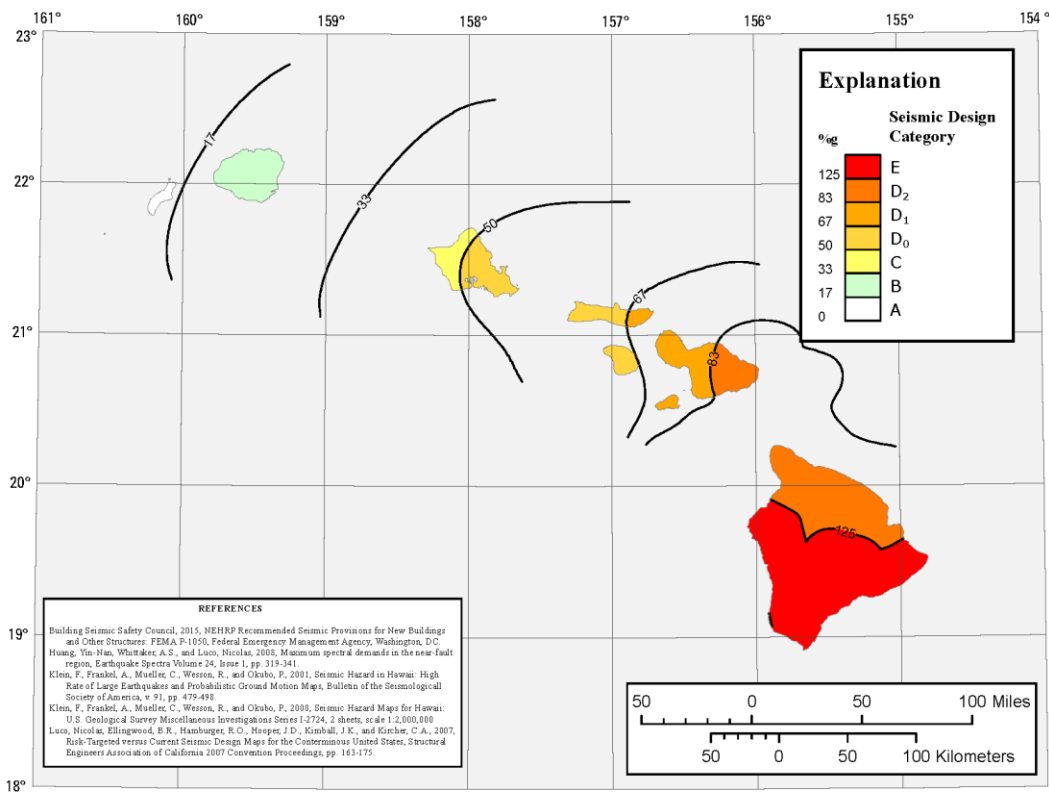
Figure 1.6-2 Seismic Design Category (SDC) map, eastern conterminous states (reprinted from the IRC).



Map prepared by U.S. Geological Survey in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council's (BSSC) Code Resource Support Committee (CRSC).

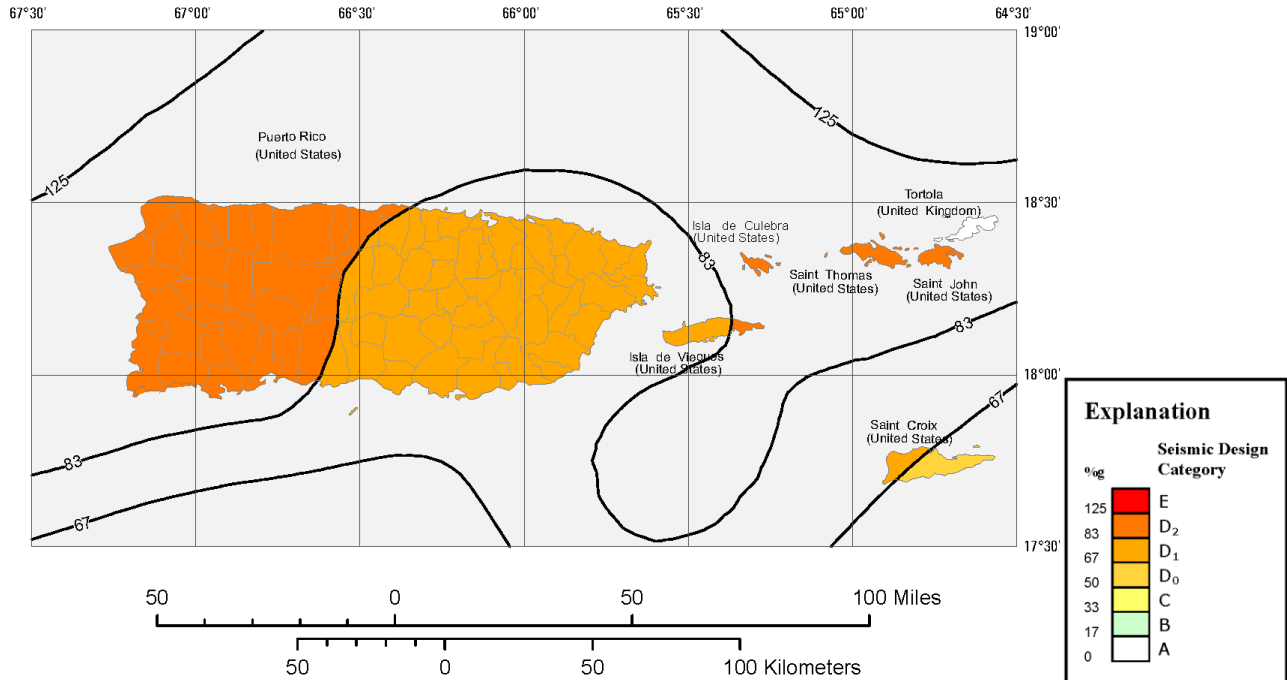
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Figure 1.6-3 Seismic Design Category (SDC) map, Alaska (reprinted from the IRC).



Map prepared by U.S. Geological Survey in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council's (BSSC) Code Resource Support Committee (CRSC).

Figure 1.6-4 Seismic Design Category (SDC) map, Hawaii (reprinted from the IRC).



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Huang, Yin-Nan, Whittaker, A.S., and Luco, Nicolas, 2008, Maximum spectral demands in the near-fault region, Earthquake Spectra Volume 24, Issue 1, pp. 319-341.

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Map prepared by U.S. Geological Survey in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council's (BSSC) Code Resource Support Committee (CRSC).

Figure 1.6-5 Seismic Design Category (SDC) map, Puerto Rico (reprinted from the IRC).

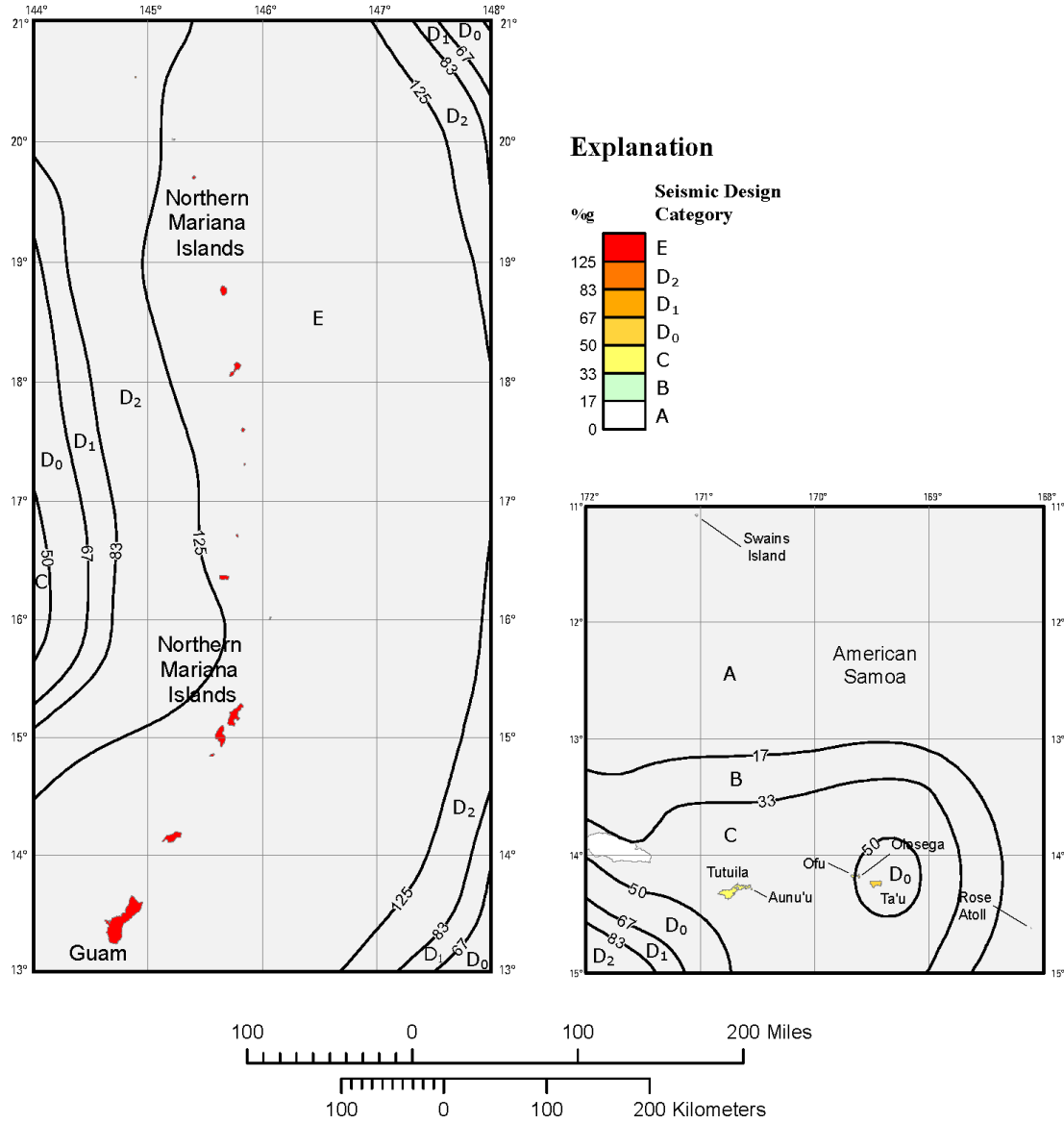


Figure 1.6-6 Seismic design category (SDC) map, Northern Mariana Islands and American Samoa (reprinted from the IRC).

Chapter 2

Definitions, Notation, and Abbreviations

2.1 Definitions

Unless otherwise expressly stated, the following words and terms shall, for the purposes of this standard, have the meanings indicated below. See Section 2.3 for reference to sources noted in brackets.

ADHERED STONE OR MASONRY VENEER [IRC]. Stone or masonry veneer secured and supported through the adhesion of an *approved* bonding material applied to an *approved* backing.

ADHESIVE ANCHOR [IEBC Appendix Chapter A3]. An assembly consisting of a threaded rod, washer, nut, and chemical adhesive approved by the *building official* for installation in existing concrete or masonry.

ANCHORED STONE OR MASONRY VENEER [IRC]. Stone or masonry veneer secured with *approved* mechanical fasteners to an *approved* backing.

ANCHOR STRAP. Structural steel tie that anchors the chimney to the dwelling framing or wood framed walls to concrete foundations.

APPROVED. Acceptable to the *building official*.

ATTIC [IRC]. The unfinished space between the ceiling assembly and the roof assembly.

BASE-LEVEL DIAPHRAGM. In a *hillside dwelling*, the framed floor at or closest in elevation to the level of the *uphill foundation*.

BRACED WALL LINE [UBC]. A straight line through the building plan that represents the location of the lateral resistance provided by that wall line.

BRACED WALL PANEL [UBC]. A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material, shear nailing, and anchors.

BRACING WALL. A wood light-frame shear wall, cripple wall, or braced wall panel serving as part of the *seismic force-resisting system*: wood structural panel sheathed *cripple walls* at the perimeter of the crawlspace in

crawlspace dwellings and *hillside dwellings* or ground story shear walls at *living-space-over-garage dwellings*.

BUILDING OFFICIAL. The officer or other designated authority charged with the administration of adopted building and residential codes, or a duly authorized representative.

CHIMNEY [IRC]. A primary vertical structure containing one or more *flues*, for the purpose of carrying gaseous products of combustion and air from a fuel-burning appliance to the outside atmosphere.

CHIMNEY, EXTERIOR. A chimney located on an outside wall with at least one face of masonry exposed to the exterior for at least one complete story.

CHIMNEY, FACTORY BUILT [IRC]. A *listed* and *labeled chimney* composed of factory-made components assembled in the field in accordance with the manufacturer's instructions and conditions of the listing.

CHIMNEY, INTERIOR. *Chimneys* not meeting the criteria for exterior chimneys.

CHIMNEY, MASONRY [IRC]. A field-constructed *chimney* composed of *solid masonry* units, bricks, stones or concrete.

CHIMNEY CAP. A concrete, metal, or stone cover for the *chimney* intended to prevent entry of snow and pests, and sloped to shed water.

CONNECTOR. A device used to provide load-path attachment for elements resisting seismic forces, including anchors to the foundation and custom or prefabricated steel clips for attachment between framing elements (sometimes referred to as a shear clip).

CRAWLSPACE DWELLING. A dwelling in which: (1) the space below the lowest framed floor is predominantly unoccupied, including area enclosed by crawlspace walls, open areas, or a combination of the two; (2) the tallest crawlspace *cripple wall clear height* does not exceed 7'-0"; and (3) when averaged across the full length or width of the dwelling the grade slope does not exceed 1 vertical in 5 horizontal.

CRAWLSPACE WALL. A framed wall, concrete wall or masonry wall extending from the top of the foundation to the underside of the floor framing of the first floor above the grade plane.

CRIPPLE WALL [IRC]. A framed wall extending from the top of the foundation to the underside of the floor framing of the first floor above grade plane.

CRIPPLE WALL CLEAR HEIGHT. The vertical height of a *cripple wall* from the top of the foundation to the underside of floor framing above.

CROSS-SLOPE LOADING. In a *hillside dwelling*, horizontal seismic loading in the direction parallel to the uphill foundation and generally parallel to grade elevation contours. *Cross-slope loading* is perpendicular to *out-of-hill loading*.

DESIGN PROFESSIONAL [IRC]. See *registered design professional*.

DWELLING [IRC]. Any building that contains one or two *dwelling units* used, intended, or designed to be built used, rented, leased, let or hired out to be occupied, or that are occupied for living purposes.

DWELLING UNIT [IRC]. A single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

FIREBOX. An assembly consisting of a hearth and fire chamber of noncombustible material and provided with a *chimney*, for use with solid fuels.

FIREPLACE, FACTORY-BUILT [IRC]. A *listed* and *labeled* fireplace and chimney system composed of factory-made components and assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

FIREPLACE, MASONRY [IRC]. A field-constructed fireplace composed of *solid masonry* units, bricks, stones, or concrete.

FIREPLACE INSERT, FACTORY-BUILT. A *listed* and *labeled* fireplace composed of factory-made components and assembled in the field within an existing masonry fireplace in accordance with manufacturer's instructions and the conditions of the listing.

FLUE [IRC]. See *vent*.

FLUE CAP. A protective covering or housing attached to the *flue* termination intended to prevent downdrafts and entry of rain, snow or pests while allowing venting of exhaust gasses. For factory installations, the flue cap shall be part of the UL *listed* system.

FOUNDATION SILL PLATE. A wood framing member providing support to a structure above and bearing on a foundation.

GROUND STORY RESIDENTIAL UNIT. In a *living-space-over-garage* dwelling, a residential unit at the garage level with interior wall finishes and interior walls.

HEIGHT ABOVE ROOF. The vertical distance from the lowest roof surface along the chimney perimeter to the top of the highest masonry unit.

HILLSIDE DWELLING. A dwelling in which: (1) the space below the lowest framed floor is predominantly unoccupied, including area enclosed by *crawlspace walls*, open areas, or a combination of the two; (2) the tallest crawlspace *cripple wall clear height* exceeds 7'-0" (or post and beam system post height exceeds 7'-0" when underfloor area is not enclosed); (3) when averaged across the full length or width of the *dwelling* the grade slope exceeds 1 vertical in 5 horizontal; and (4) where a wood light-frame crawlspace wall occurs between the base-level diaphragm and uphill foundation, the height of this crawlspace wall does not exceed 2'-0".

LABELED [IRC]. Equipment, materials or products to which have been affixed a label, seal, symbol, or other identifying mark of a nationally recognized testing laboratory, approved agency, or other organization concerned with product evaluation that maintains periodic inspection of the production of the labeled items and whose labeling indicates either that the equipment, material, or product meets identified standards or has been tested and found suitable for a specified purpose.

LIGHT-FRAME CONSTRUCTION [IRC]. Construction whose vertical and horizontal structural elements that are primarily formed by a system of repetitive wood or cold-formed steel framing members.

LISTED [IRC]. Equipment, materials, products, or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product, or service meets identified standards or has been tested and found suitable for a specified purpose.

LIVING-SPACE-OVER-GARAGE DWELLING. A dwelling in which a primary occupied living space occurs in an upper story that extends substantially or completely over a ground story constructed primarily as a garage, including utility and storage uses.

LOAD PATH CONNECTION. A connection between a retrofit element and the dwelling, intended to transmit seismic forces into and out of the retrofit element.

MASONRY FIREPLACE SURROUND. A decorative stone or masonry wall finish element that borders the fireplace on the sides or above (including the mantelpiece), extending beyond the *firebox*.

MASONRY FIREPLACE SURROUND, ADHERED STONE OR MASONRY. A surround constructed of *adhered stone or masonry veneer*.

MASONRY FIREPLACE SURROUND, ANCHORED STONE OR MASONRY. A surround constructed of *anchored stone or masonry veneer*.

MASONRY, SOLID [IRC]. Masonry consisting of solid masonry units laid contiguously with the joints between the units filled with mortar.

NATURALLY DURABLE WOOD [IRC]. The heartwood of the following species with the exception that an occasional piece with corner sapwood is permitted if 90 percent or more of the width of each side on which it occurs is heartwood.

DECAY RESISTANT. Redwood, cedar, black locust, and black walnut.

TERMITE RESISTANT. Redwood, Alaska yellow cedar, Eastern red cedar, and Western red cedar, including all sapwood of Western red cedar.

OUT-OF-HILL LOADING (Down-hill loading). In a *hillside dwelling*, horizontal seismic loading parallel to the direction of descending grade, acting into or away from the hillside.

PERIMETER FOUNDATION. A foundation system that is located under the dwelling perimeter walls.

POST-INSTALLED ANCHOR. An anchor installed into existing already placed or cast concrete or masonry. Post-installed anchors for purposes of this standard include *approved adhesive anchors* and concrete screws.

PRESERVATIVE TREATED WOOD [IRC]. Wood treated in conformance with the applicable requirements of AWPA U1 and AWPA M4.

PRIMARY ANCHOR [LABC, modified]. In hillside dwellings, an anchor located at *base level diaphragm* ends and offsets or transitions and providing direct connection between the *base-level diaphragm* and the *uphill foundation*. Primary loading is tension in the out-of-hill direction, due to either to direct tension or torsion from cross-hill loading.

PROPRIETARY SHEAR WALL. A pre-engineered, pre-fabricated wood or cold-formed steel load-bearing or non-load-bearing wall assembly with sheathing or bracing, serving as a vertical element of the seismic force-resisting system in place of site-built shear walls. Also known as lateral force-resisting vertical assembly (LFRVA).

REGISTERED DESIGN PROFESSIONAL [IRC]. An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

REPOINTING. The partial reconstruction of cracked or deteriorated mortar joints between solid brick masonry units by removing unsound mortar and replacing it with new mortar.

RETROFIT ELEMENT. A primary element of the seismic force-resisting system, including *cripple walls* in *crawlspace dwellings*, ground story *bracing walls* in *living-space-over-garage dwellings*, and *crawlspace walls* and *base-level diaphragm* anchorage to the uphill foundation in *hillside dwellings*.

SECONDARY ANCHOR [LABC, modified]. In *hillside dwellings*, regularly spaced anchors providing redundant, distributed connections between the *base-level diaphragm* and the *uphill foundation*.

SEISMIC DESIGN CATEGORY (SDC) [IRC]. A classification assigned to a structure based on its occupancy category and the severity of the design earthquake ground motion at the site.

SEISMIC FORCE-RESISTING SYSTEM [IBC]. That part of the structural system that has been considered in the design to provide the required resistance to seismic forces.

SHEAR WALL [IRC]. A general term for walls that are designed and constructed to resist racking from seismic and wind loads by use of masonry concrete, cold-formed steel or wood framing.

SILL PLATE. See *foundation sill plate*.

SITE CLASS [IBC, modified]. A classification assigned to a site based on the types of soils present and their engineering properties, as defined in IBC Section 1613.3.2 (also ASCE/SEI 7, Chapters 11 and 20).

SLAB-ON-GROUND. A concrete slab supported directly on grade over its full extent, cast monolithically with continuous thickened slab footings, or as a floating slab, independent of surrounding footings. Also referred to as slab-on-grade.

SMOKE CHAMBER. The enlarged vent space immediately above the *firebox* and below the chimney *flue*.

SNUG TIGHT [IEBC]. As tight as an individual can torque a nut on a bolt by hand, using a wrench with a 10-inch long handle, and the point at which the full surface of the plate washer is contacting the wood member and slightly indenting the wood surface.

SPLIT LEVEL [IRC Section R301.2.2.6, Item 5, modified]. Where portions of a floor level are vertically offset, except where framing at each level is supported directly on a continuous foundation or stem wall or where the floor framing on either side of the offset is tied together to not move differentially.

STEM WALL. A concrete or masonry wall bearing on a foundation and supporting structure above. For purposes of cripple wall and crawlspace wall retrofits, the stem wall acts as an extension of the foundation.

TIE-DOWNS. A device used in framed bracing walls or cripple walls to resist uplift through the combination of a threaded rod, anchors, and pre-manufactured metal components.

TOWNHOUSE [IRC]. A single-family *dwelling unit* constructed in a group of three or more attached units in which each unit extends from foundation to roof and with a yard or public way on not less than two sides.

TOWNHOUSE STRUCTURE. A structure comprising three or more attached *townhouse* units.

UPHILL FOUNDATION. In a *hillside dwelling*, the foundation at the side of the dwelling that has the highest top of foundation elevation.

VENT [IRC]. A passageway for conveying flue gases from fuel-fired appliances, or their vent connectors, to the outside atmosphere.

WEIGHT CLASSIFICATION. The classification of light, medium, or heavy construction as a measure of a dwelling's overall seismic mass, for use in applicable prescriptive retrofit design procedures.

WOOD STRUCTURAL PANEL [IRC, modified]. A panel manufactured from veneers or wood strands or wafers bonded together with waterproof synthetic resins or other suitable bonding systems. For purposes of this standard, wood structural panels include plywood and oriented strand board (OSB).

2.2 Notation

Unless otherwise expressly stated, the following notation, for the purposes of this standard, have the meanings indicated below.

ASD = Allowable stress design

C_d = Deflection amplification factor

CMU = Concrete masonry unit

f'_c = Compressive strength of concrete

F = Seismic base shear parameter, varying with the number of stories

F_R = Loading at roof level

F_y = Yield strength of steel

F_{2nd} = Load at the second level

h_{sx} = The story height below level x

MCE_R = Maximum considered risk targeted earthquake

R = Response modification coefficient

S_{DS} = Design, five percent damped, spectral response acceleration parameter at short periods

SDC = Seismic Design Category

V = Total design lateral force or shear at the base of a structure

W = Effective seismic weight of the structure

Ω_0 = Overstrength factor

2.3 Sources of Definitions

The following are sources of text noted in this standard:

[ASCE/SEI 7] Minimum Design Loads and Associated Criteria for Buildings and other Structures, 2016 Edition

[IBC] International Building Code, 2018 Edition

[IEBC] International Existing Building Code, 2018 Edition

[IRC] International Residential Code, 2018 Edition

[LABC] City of Los Angeles Building Code, 2016 Edition

[UBC] Uniform Building Code, 1994 and 1997 Editions

2.4 Abbreviations

The following are abbreviations incorporated into standard figures.

(E) Existing

(N) New

blkg Blocking

btm Bottom

clr Clear

Dia Diameter

ea Each

EMB Embed

Gr Grade

Hgr Hanger

l.s.h Long slotted hole

Max. Maximum

Min. Minimum

m.b. Bolt

NTS Not to scale

o.c. On center

s.o.g. Slab-on-ground

Typ. Typical

WF Wide flange

Chapter 3

Minimum Construction Requirements

This chapter provides minimum requirements for materials and construction of retrofits designed in accordance with this standard.

Exception. Minimum material and construction requirements shall be permitted to be in accordance with the adopted building or residential code in lieu of this chapter.

3.1 General

3.1.1 Existing Conditions

No retrofit work shall be directly attached to or enclose existing elements that are damaged or deteriorated to an extent that could significantly affect gravity or seismic load-carrying capacity. Any such existing elements shall be addressed prior to or at the time of retrofit construction. Where possible, damaged or deteriorated elements shall be repaired in place or supplemented with new elements. Otherwise, damaged or deteriorated members shall be replaced.

3.1.2 Shoring and Bracing

Shoring and bracing shall be provided, as required, to temporarily support existing *dwelling* elements to remain and to safely install new work.

3.2 Materials

Material newly incorporated into retrofit work shall comply with the building code, but not less than the following.

3.2.1 Sawn Lumber

Sawn lumber shall be identified by a grade mark of an accredited lumber grading or inspection agency and shall have design values certified by an accreditation body that complies with Department of Commerce (DOC) Standard PS 20. In lieu of a grade mark, a certification of inspection shall be issued by a lumber grading or inspection agency. Unless otherwise noted, framing required by this standard shall be of Douglas fir-Larch species, or a species of equal or greater specific gravity.

3.2.2 *Preservative Treated Lumber*

All lumber and wood structural panels in contact with foundations or exposed to weather shall be pressure-*preservative treated* and dried after treatment in accordance with AWWA U1 (Commodity specification A, Use Category 4B and Section 5.2) and shall bear the label of an accredited agency. Where lumber and/or wood structural wall panels are cut or drilled after treatment, the cut or drilled surface shall be treated in accordance with copper naphthenate in accordance with AWWA M4.

3.2.3 *Wood Structural Panel Sheathing*

Wood structural panel sheathing shall conform to Department of Commerce Voluntary Product Standard DOC PS1 or PS2. Sheathing shall be Exposure 1 or Exterior Exposure, manufactured with exterior glue, and shall be of minimum 4-ply. Panels shall be identified for grade, bond, classification, and performance category by a grade mark of certification of inspection issued by an *approved* agency. Wood structural panels permitted for use in this standard are limited to plywood and oriented strand board (OSB).

3.2.4 *Cold-Formed Steel*

Sheet steel shall conform to ASTM A1003, Structural Grade 33 Type H or Grade 50 Type H.

Cold-formed steel framing members shall be cold formed to shape from structural quality sheet steel. Wall studs shall be C-shaped sections with a minimum thickness of 43 mil (18 gage), a minimum flange width of 1-5/8 inches and a minimum depth of 2-1/2 inches.

3.2.5 *Minimum Fastening*

Nails specified in this standard shall be common nails conforming to ASTM F1667. Eight-penny (8d) common nails shall be 2-1/2" × 0.131" common nails. Fastening not otherwise specified shall meet the minimum requirements of IRC Table R602.3(1), reprinted here as Table 3.2-1, or the adopted building or residential code. Alternate fastening shall be as specifically approved.

Fasteners in contact with preservative treated lumber or wood structural panels exposed to weather shall be Type 304 or 316 stainless steel, hot-dipped galvanized or hot-tumbled galvanized. Electro galvanized steel nails and steel staples with any coating shall not be permitted.

Table 3.2-1 Minimum Fastening Requirements, IRC Table R602.3(1)
TABLE R602.3(1)

FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER ^{a, b, c}	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists or rafters to top plate	4-8d box (2½" × 0.113") or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Toe nail
2	Ceiling joists to top plate	4-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions (see Section R802.5.2 and Table R802.5.2)	4-10d box (3" × 0.128"); or 3-16d common (3½" × 0.162"); or 4-3" × 0.131" nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) (see Section R802.5.2 and Table R802.5.2)	Table R802.5.2	Face nail
5	Collar tie to rafter, face nail or 1¼" × 20 ga. ridge strap to rafter	4-10d box (3" × 0.128"); or 3-10d common (3" × 0.148"); or 4-3" × 0.131" nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box nails (3½" × 0.135"); or 3-10d common nails (3" × 0.148"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss ⁱ
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2" ridge beam	4-16d (3½" × 0.135"); or 3-10d common (3" × 0.148"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	Toe nail
		3-16d box 3½" × 0.135"); or 2-16d common (3½" × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3½" × 0.162")	24" o.c. face nail
		10d box (3" × 0.128"); or 3" × 0.131" nails	16" o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3½" × 0.135"); or 3" × 0.131" nails	12" o.c. face nail
		16d common (3½" × 0.162")	16" o.c. face nail
10	Built-up header (2" to 2" header with ½" spacer)	16d common (3½" × 0.162")	16" o.c. each edge face nail
		16d box (3½" × 0.135")	12" o.c. each edge face nail
11	Continuous header to stud	5-8d box (2½" × 0.113"); or 4-8d common (2½" × 0.131"); or 4-10d box (3" × 0.128")	Toe nail
12	Top plate to top plate	16d common (3½" × 0.162")	16" o.c. face nail
		10d box (3" × 0.128"); or 3" × 0.131" nails	12" o.c. face nail
13	Double top plate splice	8-16d common (3½" × 0.162"); or 12-16d box (3½" × 0.135"); or 12-10d box (3" × 0.128"); or 12-3" × 0.131" nails	Face nail on each side of end joint (minimum 24" lap splice length each side of end joint)

(continued)

Table 3.2-1 Minimum Fastening Requirements, IRC Table R602.3(1) (continued)

**TABLE R602.3(1)—continued
FASTENING SCHEDULE**

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER ^{a, b, c}	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3 ¹ / ₂ " × 0.162")	16" o.c. face nail
		16d box (3 ¹ / ₂ " × 0.135"); or 3" × 0.131" nails	12" o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3 ¹ / ₂ " × 0.135"); or 2-16d common (3 ¹ / ₂ " × 0.162"); or 4-3" × 0.131" nails	3 each 16" o.c. face nail 2 each 16" o.c. face nail 4 each 16" o.c. face nail
16	Top or bottom plate to stud	4-8d box (2 ¹ / ₂ " × 0.113"); or 3-16d box (3 ¹ / ₂ " × 0.135"); or 4-8d common (2 ¹ / ₂ " × 0.131"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	Toe nail
		3-16d box (3 ¹ / ₂ " × 0.135"); or 2-16d common (3 ¹ / ₂ " × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	End nail
17	Top plates, laps at corners and intersections	3-10d box (3" × 0.128"); or 2-16d common (3 ¹ / ₂ " × 0.162"); or 3-3" × 0.131" nails	Face nail
18	1" brace to each stud and plate	3-8d box (2 ¹ / ₂ " × 0.113"); or 2-8d common (2 ¹ / ₂ " × 0.131"); or 2-10d box (3" × 0.128"); or 2 staples 1 ³ / ₄ "	Face nail
19	1" × 6" sheathing to each bearing	3-8d box (2 ¹ / ₂ " × 0.113"); or 2-8d common (2 ¹ / ₂ " × 0.131"); or 2-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., 1 ³ / ₄ " long	Face nail
20	1" × 8" and wider sheathing to each bearing	3-8d box (2 ¹ / ₂ " × 0.113"); or 3-8d common (2 ¹ / ₂ " × 0.131"); or 3-10d box (3" × 0.128"); or 3 staples, 1" crown, 16 ga., 1 ³ / ₄ " long	Face nail
		Wider than 1" × 8" Face nail 4-8d box (2 ¹ / ₂ " × 0.113"); or 3-8d common (2 ¹ / ₂ " × 0.131"); or 3-10d box (3" × 0.128"); or 4 staples, 1" crown, 16 ga., 1 ³ / ₄ " long	
Floor			
21	Joist to sill, top plate or girder	4-8d box (2 ¹ / ₂ " × 0.113"); or 3-8d common (2 ¹ / ₂ " × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Toe nail
22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d box (2 ¹ / ₂ " × 0.113")	4" o.c. toe nail
		8d common (2 ¹ / ₂ " × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails	6" o.c. toe nail
23	1" × 6" subfloor or less to each joist	3-8d box (2 ¹ / ₂ " × 0.113"); or 2-8d common (2 ¹ / ₂ " × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., 1 ³ / ₄ " long	Face nail

(continued)

Table 3.2-1 Minimum Fastening Requirements, IRC Table R602.3(1) (continued)

**TABLE 602.3(1)
FASTENING SCHEDULE—continued**

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER ^{a, b, c}	SPACING AND LOCATION	
Floor				
24	2" subfloor to joist or girder	3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162")	Blind and face nail	
25	2" planks (plank & beam—floor & roof)	3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162")	At each bearing, face nail	
26	Band or rim joist to joist	3-16d common (3½" × 0.162") 4-10 box (3" × 0.128"), or 4-3" × 0.131" nails; or 4-3" × 14 ga. staples, 7/16" crown	End nail	
27	Built-up girders and beams, 2-inch lumber layers	20d common (4" × 0.192"); or	Nail each layer as follows: 32" o.c. at top and bottom and staggered.	
		10d box (3" × 0.128"); or 3" × 0.131" nails	24" o.c. face nail at top and bottom staggered on opposite sides	
		And: 2-20d common (4" × 0.192"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Face nail at ends and at each splice	
28	Ledger strip supporting joists or rafters	4-16d box (3½" × 0.135"); or 3-16d common (3½" × 0.162"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	At each joist or rafter, face nail	
29	Bridging or blocking to joist	2-10d box (3" × 0.128"), or 2-8d common (2½" × 0.131"); or 2-3" × 0.131" nails	Each end, toe nail	
ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER ^{a, b, c}	SPACING AND LOCATION	
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel exterior wall sheathing to wall framing]				
30	¾" – ½"	6d common (2" × 0.113") nail (subfloor, wall) ⁱ 8d common (2½" × 0.131") nail (roof); or RSRS-01 (2¾" × 0.113") nail (roof) ^j	6	12 ^f
31	19/32" – 1"	8d common nail (2½" × 0.131"); or RSRS-01; (2¾" × 0.113") nail (roof) ^j	6	12 ^f
32	1⅛" – 1¼"	10d common (3" × 0.148") nail; or 8d (2½" × 0.131") deformed nail	6	12 ^f
Other wall sheathing^g				
33	½" structural cellulosic fiberboard sheathing	1½" galvanized roofing nail, 7/16" head diameter, or 1¼" long 16 ga. staple with 7/16" or 1" crown	3	6
34	25/32" structural cellulosic fiberboard sheathing	1¾" galvanized roofing nail, 7/16" head diameter, or 1½" long 16 ga. staple with 7/16" or 1" crown	3	6
35	½" gypsum sheathing ^d	1½" galvanized roofing nail; staple galvanized, 1½" long; 1¼" screws, Type W or S	7	7
36	5/8" gypsum sheathing ^d	1¾" galvanized roofing nail; staple galvanized, 1⅝" long; 1⅝" screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
37	¾" and less	6d deformed (2" × 0.120") nail; or 8d common (2½" × 0.131") nail	6	12
38	7/8" – 1"	8d common (2½" × 0.131") nail; or 8d deformed (2½" × 0.120") nail	6	12
39	1⅛" – 1¼"	10d common (3" × 0.148") nail; or 8d deformed (2½" × 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

(continued)

Screws for steel-to-steel connections shall be No. 8 self-drilling tapping screws that conform to ATSM C1513. Screws for attaching structural sheathing to cold-formed steel wall framing shall have a minimum head diameter of 0.292 inch with countersunk heads and shall be installed with a minimum edge distance of 3/8-inch. Gypsum board shall be attached to cold-formed steel with minimum No. 6 screws conforming to ASTM C954 or ASTM C1513 with a bugle-head style.

3.2.6 Connectors

Connectors shall be custom or pre-engineered pre-manufactured devices, approved by the *building official* and installed in accordance with the manufacturer's instructions. Connectors protected from weather shall be provided with a minimum of G90 zinc coating in accordance with ASTM A653. Connectors exposed to weather or in contact with preservative treated wood shall be provided with a minimum hot-dipped galvanized coating or G185 coating in accordance with ASTM A653, and fasteners conforming to ASTM A153.

3.2.7 Concrete

Concrete shall have a minimum specified compression strength, f'_c , of not less than 2,500 psi at 28 days. Materials used to produce concrete and testing thereof shall comply with the applicable standards listed in Chapters 19 and 20 of ACI 318 or ACI 332.

3.2.8 Reinforcing Steel

Steel reinforcement shall comply with the requirements of ASTM A615, A706 or A996. ASTM A996 bars produced from rail steel shall be Type R. The minimum yield strength of reinforcing shall be 40,000 psi (Grade 40). Reinforcement shall be secured in the proper location in the forms with tie wire or other support system to prevent displacement during concrete placement operations.

Reinforcing steel to be welded shall conform to ASTM A706.

3.2.9 Structural Steel

Structural steel sections shall comply with the requirements of ASTM A36, A572 or A992 for steel plates and sections. Structural steel HSS sections shall comply with ASTM A500, Grade B, $F_y = 46$ ksi. Identification of structural steel shall comply with the requirements of AISC 360.

Sheet steel for brick chimney adaptor cones shall conform to ASTM A1003, Structural Grade 33 Type H or Grade 50 Type H. Welding shall conform to AWS D1.3.

3.2.10 Bolts and Threaded Rods

Bolts shall conform to ASTM A307. Threaded rods shall conform to ASTM A36. Except where otherwise specifically required, cut washer between bolt head or nut and wood member shall be provided. Bolts, nuts, and washers exposed to weather or in contact with preservative treated wood shall be hot-dipped galvanized.

3.2.11 Post-Installed Anchors

Post-installed anchors used for *tie-down* anchors or anchor bolts shall be approved by the *building official* and installed in accordance with the manufacturer's instructions. *Adhesive anchors* shall be used for tie-down anchors. Anchor bolts shall be adhesive anchors or concrete screws, provided the foundation into which the anchor is being installed is in conformance with the manufacturer's installation requirements.

3.2.12 Proprietary Shear Walls

Proprietary shear walls shall be prefabricated wood shear panels or prefabricated cold-formed steel shear panels complying with the requirements of ICC-ES AC 436, FEMA P-795 (FEMA, 2011), or shall have been tested in accordance with ASTM D7989, in a manner and with documentation acceptable to the building official. Proprietary shear walls shall be installed in accordance with the manufacturer's installation requirements and the provisions of this standard.

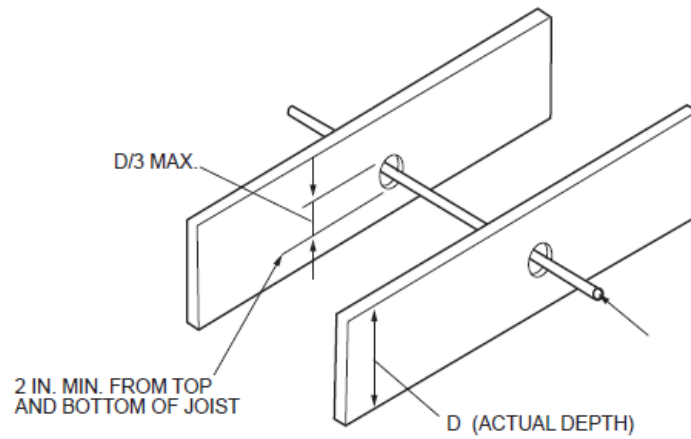
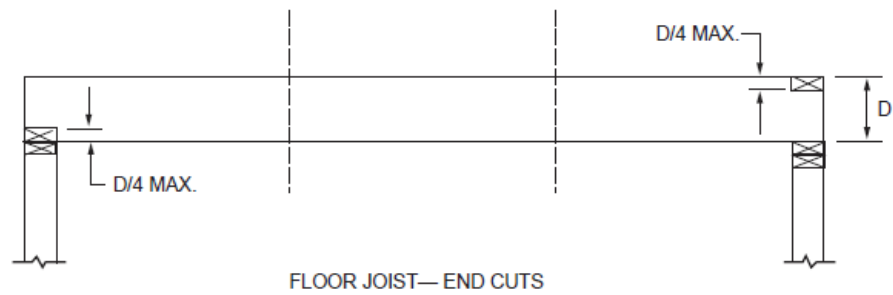
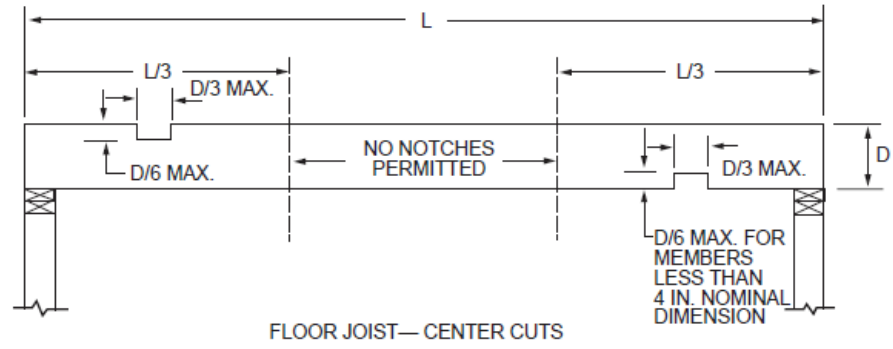
3.3 Installation

3.3.1 General

All new retrofit construction shall be in accordance with this section.

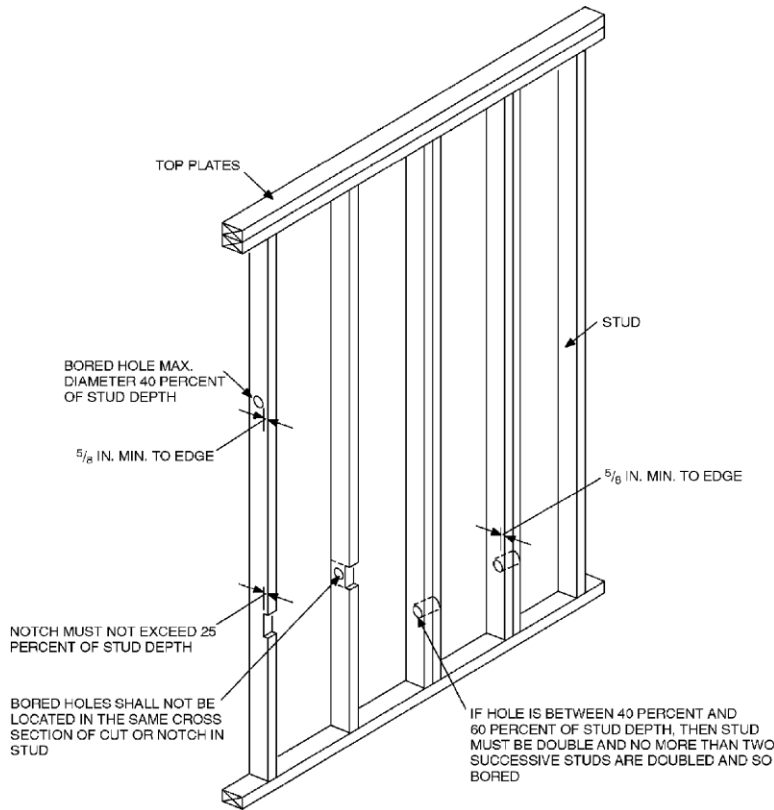
3.3.2 Notching and Boring

Solid sawn framing and sheathing shall not be notched or bored, except as specifically shown in the retrofit design, per IRC Figure R502.8 and R602.6(1), reprinted here as Figure 3.3-1 and Figure 3.3-2, or as approved. Engineered wood products shall not be notched or bored.



**FIGURE R502.8
CUTTING, NOTCHING AND DRILLING**

Figure 3.3-1 Notching and boring of solid-sawn framing, IRC Figure R502.8.



For SI: 1 inch = 25.4 mm.
 Note: Condition for exterior and bearing walls.

FIGURE R602.6(1)
 NOTCHING AND BORED HOLE LIMITATIONS FOR EXTERIOR WALLS AND BEARING WALLS

Figure 3.3-2 Notching and boring of solid-sawn framing, IRC Figure R602.6(1).

3.3.3 Anchorage to Existing Concrete

Anchors installed in existing concrete shall comply with all edge and end distances, as specified in this standard and the retrofit plans. Existing reinforcing steel shall not be drilled through. If reinforcing steel is hit during drilling, the hole shall be relocated a minimum of one inch clear of the initial hole, and the initial hole shall be filled with non-shrink grout.

3.3.4 Anchor Bolt Installation

New anchor bolts shall be provided at each perimeter wall *foundation sill plate*. Anchor bolts shall be spaced between 8 and 12 inches from each end of each section of foundation sill plate, and at the on-center spacing required by the retrofit provisions of this standard. Where existing sections of foundation sill plate are 24 inches or less in length, one anchor bolt shall be provided near center of the sill plate length. Foundation retrofit anchors shall be provided where the configuration does not permit the installation of new

anchor bolts. Spacing from end of foundation sill plate and on-center spacing shall be as required for anchor bolts.

Steel plate washers, not less than $0.227 \times 3 \times 3$ inches, shall be provided on each anchor bolt. The edge of the plate washer shall be placed within 1/2-inch of face of wood structural wall sheathing where wall is sheathed, and within 1/2-inch of inside face of exterior finish where wall is not sheathed.

3.3.5 Wood Structural Panel Sheathing

Wood structural panel sheathing shall be installed with 1/8-inch gaps at edges and ends of panels. Sheathing shall be laid out with its span direction (strength axis) perpendicular to supporting studs. Edge nailing, of the nail type and size specified in the retrofit design, shall be provided at each edge of each sheathing panel. A minimum distance of 3/8-inch shall be provided from center of nail to edge of sheathing panel. Provide new 2-2×, 3× or 4× studs where sheathing panels abut at a vertical joint. Provide 3× or 4× minimum blocking at all panel edges not otherwise falling on framing. No piece of new installed wood structural wall sheathing shall be less than 24 inch × 24 inch.

Sheathing nail heads shall be driven flush with the face of the sheathing. Where sheathing nails are overdriven to the extent that the nail head fractures the sheathing face, one additional nail shall be provided for each two overdriven nails. Added nails shall be spaced between existing.

3.3.6 Fasteners

Fasteners shall be installed in a manner so as to not cause splitting of the framing members. Where required to avoid splitting, nail holes shall be predrilled to 75 percent of the nail shank diameter. All holes for bolts shall be predrilled to 1/16-inch over bolt shank.

3.3.7 Connectors

Connectors shall be of the type and size specified in this standard, and shall be installed using the number and type of fasteners specified in the manufacturer's installation instructions. Connectors shall be distributed as specified by the applicable retrofit schedule or detail.

3.3.8 Structural Steel

The fabrication, corrosion protection, and erection of structural steel shall be in accordance with AISC 360. Welding of structural steel shall be in accordance with AWS D1.1.

3.3.9 Reinforcing Steel

Reinforcing steel fabrication, including bend radius and other detailing, shall be in accordance with the CRSI Manual of Practice. Lap splices shall not be less than 36 inches for #4 bars, 48 inches for #5 bars, and 60 inches for #6 bars. All straight bars shall be terminated with standard hooks unless otherwise noted. At foundation corners, each straight bar shall be extended all the way across the foundation to the minimum clear distance from the far edge and terminated with a 12-inch hook.

Welding of reinforcing steel shall be in accordance with AWS D1.4.

Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches (75 mm). Minimum cover for concrete cast in removable forms that will be exposed to the earth or weather shall be 1-1/2 inches (38 mm) for No. 5 bars or smaller, and 2 inches (50 mm) for No. 6 bars and larger.

Where lap splices occur, lap splices shall be provided in accordance with Table 3.3-1.

	No. 4	No. 5
Horizontal bars with more than 12 inches concrete below	32 inches	42 inches
Other bars	24 inches	32 inches

12-inch long hooks shall be provided at all corners and intersections.

3.3.10 Crawlspace Ventilation and Access Openings

Where the existing area and distribution of crawlspace ventilation is modified by the retrofit work, it shall be demonstrated that the modified area and distribution meet the requirements of the adopted building or residential code. Where the existing crawlspace access openings are modified by the retrofit work, it shall be demonstrated that modified access openings meet the requirements of the adopted building or residential code.

3.3.11 Special Inspections

Special inspection by a third party inspector approved by the building official shall be provided for welding of structural steel.

Special inspection in accordance with the adopted building code and by a third party inspector approved by the building official shall be provided for seismic retrofit of hillside dwellings.

For *crawlspace dwellings, living-space-over-garage dwellings, chimneys* and *masonry fireplace surrounds*, special inspection by a third party inspector is not required for the following:

- Concrete or reinforcing steel for foundations provided a building department inspection is performed prior to placement of concrete. Design is based on an ultimate concrete strength of 2,500 psi or less.
- Installation of cast-in-place or *post-installed anchors* for anchor bolts.
- Installation of adhesive anchors for tie-down devices, provided that each anchor is torque-tested to 15 foot-pounds for 1/2-inch diameter anchors and 20 foot-pounds for 5/8-inch diameter anchors with no movement of anchor.
- Nailing of wood structural panel shear walls, provided a building department inspection is performed.

Chapter 4

Vulnerability-Based Assessment and Retrofit of Crawlspace Dwellings

4.1 General

This chapter contains provisions for vulnerability-based assessment and retrofit of wood light-frame *crawlspace dwellings* supported on a raised *cripple wall* and foundation systems (Figure 4.1-1, Configuration A) or supported directly on a foundation system (Figure 4.1-2, Configuration B). Where both occur in a single dwelling, dwellings shall be assessed for both Configuration A and Configuration B. Vulnerabilities addressed by this chapter are:

- At cripple walls and foundation systems (Configuration A)
 - Connection to the framing above (A)
 - Cripple wall sheathing (B)
 - *Foundation sill plate* anchorage to the foundation (C)
- At foundation *stem walls* or foundations without cripple walls (Configuration B)
 - Connection to the dwelling above (A)
 - *Foundation sill plate* anchorage to foundation (B)

The primary purpose of this chapter is the reduction of earthquake-induced damage to wood light-frame crawlspace dwellings.

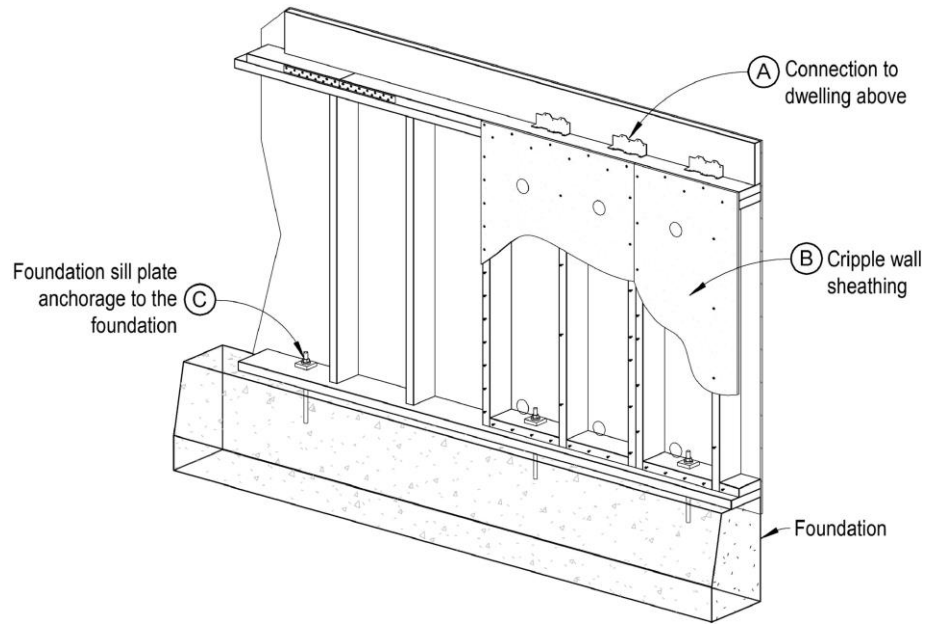


Figure 4.1-1 Example illustration of Configuration A.

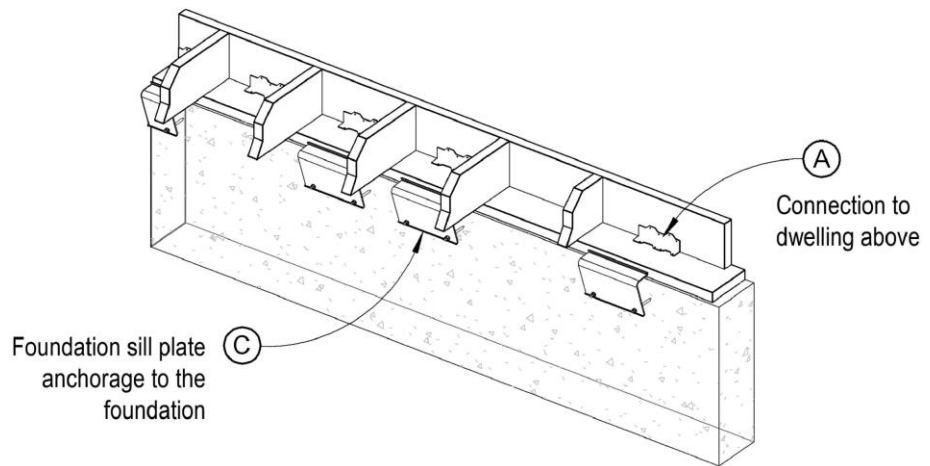


Figure 4.1-2 Example illustration of Configuration B.

4.1.1 Use of this Chapter

In addition to the scope limits of Section 1.8, the dwelling shall comply with all of the eligibility criteria of Table 4.1-1. Where the dwelling is not compliant with one or more of the eligibility statements, assessment and retrofit in accordance with this chapter shall not be permitted.

4.1.2 Vulnerability-Based Assessment and Retrofit Methods

Where a dwelling complies with Section 4.1.1, the dwelling need not be assessed and may be retrofitted in accordance with the prescriptive retrofit provisions of Section 4.4 or the simplified engineered retrofit provisions of Section 4.5 as applicable. If the dwelling does not comply with Section

4.1.1, assessment shall be in accordance with Section 4.3; alternately, assessment is not required if retrofit is to be provided. Where retrofit is required by Section 4.3, retrofit shall be in accordance with Section 4.1.3 or Section 4.1.4.

Table 4.1-1 Eligibility Criteria for Use of Chapter 4

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is a detached <i>one-</i> or <i>two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> and assessment and retrofit will occur for each attached <i>townhouse unit</i> (the full <i>townhouse structure</i>).		
2	The dwelling is a wood light-frame dwelling that is two stories or less.		
3	The dwelling is a crawlspace dwelling as defined in Chapter 2 and the perimeter walls of the occupied stories (not including porches or other appurtenances) are supported on: <ul style="list-style-type: none"> a. Cripple walls foundation systems (Configuration A), or b. Foundation stem walls or foundations without cripple walls (Configuration B), or c. Post and pier systems to be retrofitted with cripple walls, or d. Cripple wall foundation systems or foundation without cripple walls in combination with a <i>slab-on-ground</i> foundation. 		
4	The dwelling has a continuous <i>perimeter foundation</i> (not including porches or other appurtenances), concrete stem walls or will be retrofitted to have a continuous perimeter foundation.		
5	Cripple walls, where they occur, do not exceed 7'-0" in clear height.		
6	The maximum slope as measured from the top of foundations along one edge of the home to the other end does not exceed 5 to 1 (horizontal to vertical) or 20%.		

4.1.3 Prescriptive Retrofit

For dwellings that meet the eligibility criteria of Table 4.1-1 and all of the additional eligibility criteria of Table 4.1-2, retrofit of the non-conforming conditions shall be permitted to use the prescriptive retrofit provisions of Section 4.4.

4.1.4 Simplified Engineered Retrofit

Where the prescriptive retrofit provisions of Section 4.4 are not used, a simplified engineered retrofit shall be provided in accordance with Section 4.5.

Table 4.1-2 Additional Eligibility Criteria for Use of Prescriptive Retrofit Provisions of Section 4.4

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is assigned to <i>Seismic Design Category</i> (SDC) B through E in accordance with Section 1.6.		
2	The weight of roofing material shall not exceed 12 psf except where allowed by Section 4.4.10 for one-story crawlspace dwellings with clay tile roofing.		
3	Weight of exterior wall finish shall not exceed 10 psf, except veneer wainscots supported on concrete or masonry foundations that are permitted to extend up to four feet above the top of foundation.		
4	Weight of interior wall finish shall not exceed 8 psf, except <i>masonry fireplace surrounds</i> not more than 4 inches thick and not more than 100 square feet in area are permitted to exceed this weight.		
5	Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limited to 25% of the total floor area of each level.		
6	Floors in each story are at the same elevation, excluding slab-on-ground portions.		
7	The maximum square footage of the dwelling, excluding areas supported on slabs on grade, do not exceed 3,000 square feet for one-story dwellings and 4,000 square feet for two-story dwellings.		
8	No part of the foundations is constructed of unreinforced masonry or stone.		
9	Clear floor to ceiling heights at any occupied level do not exceed 9 feet.		
10	There is no indication that an engineered <i>seismic force-resisting system</i> is present in the dwelling (engineered plans, visible <i>tie-down</i> brackets).		

4.2 Definitions and Minimum Requirements

The definitions of Chapter 2 are applicable to all assessments and all retrofits designed in accordance with Chapter 4. The minimum requirements of Chapter 3 are applicable to all retrofits designed in accordance with Chapter 4. See Figure 4.4-18 for minimum requirements at existing single and double top plate splices, cutouts at braced wall panels, and allowable notching and reinforcing for cripple wall top plates and studs.

4.3 Vulnerability-Based Assessment

4.3.1 Scope

The assessment criteria of this section shall be used to determine whether existing foundations, anchorage, cripple walls, and connections are in compliance with the requirements of this chapter. Where they are in compliance with the requirements of this chapter, retrofit is not required. Where they are found to not be in compliance with the requirements of this chapter, retrofit in accordance with Section 4.4, Section 4.5, or a general engineered retrofit is required. The assessment provisions of Section 4.3 shall be permitted to be used provided existing cripple wall heights are 4 feet or less, and first floor framing is supported directly on cripple walls, a

foundation sill, or any combination of the two, and where any existing retrofit work to be considered in the assessment obtained a building permit prior to the date of original publication of this standard.. Where Section 4.3.2 requires a detailed assessment, this detailed assessment shall be provided in accordance with Section 4.3.3.

In lieu of a detailed assessment, the dwelling may be retrofitted in accordance with Section 4.4 or 4.5 as applicable.

4.3.2 Simplified Assessment

Crawlspace dwellings shall be assessed in accordance with Table 4.3-1. Each existing element listed in Table 4.3-1 and members to which these elements are directly attached, shall be assessed to identify incomplete or inadequate installation, damage, and deterioration that might significantly affect seismic performance. Where this assessment identifies incomplete or inadequate installation, damage or deterioration, the elements shall be deemed not adequate for use. For these conditions, the applicable assessment statement within Table 4.3-1 shall be determined to be false and the indicated compliance step taken. Alternately, a detailed assessment of existing elements in accordance with Chapter 8 may be provided.

The scope of this assessment shall be permitted to be based on the judgment of the evaluator. The findings and documentation of this investigation shall be subject to the approval of the *building official* where required.

Table 4.3-1 Simplified Structural Assessment for Crawlspace Dwellings

Item	Existing Configuration	Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance Step if Unknown
1	A	The tallest cripple wall height does not exceed 4 feet.	Proceed to Item 2.	Provide engineered assessment or retrofit of sheathing, anchorage to foundation, and connection to dwelling above.	Not applicable.
2	A, B	Existing concrete foundation condition is adequate for use.	Retrofit of foundation is not required.	Retrofit of foundation is required.	Provide detailed assessment of foundation in accordance with Section 8.1.

Table 4.3-1 Simplified Structural Assessment for Crawlspace Dwellings (continued)

Item	Existing Configuration	Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance Step if Unknown
3	A1	For the cripple wall with foundation system, the connectors to dwelling above are in condition adequate for use and are spaced on average, a maximum of 32 inches on center for a one-story dwelling or 16 inches on center for a two-story dwelling on average along each perimeter wall line.	Retrofit of connectors to dwelling above is not required.	Retrofit of connectors to dwelling above is required.	Provide detailed assessment or retrofit of connectors to dwelling above.
4	B1	For foundations without cripple walls, connectors to dwelling above are in adequate condition and are spaced on average a maximum, 32 inches on center for a one-story dwelling, or 16 inches on center for a two-story dwelling on average along each perimeter wall line.	Retrofit of connectors to dwelling above is not required.	Retrofit of connectors to dwelling above is required.	Provide detailed assessment or retrofit of connectors to dwelling above.
5	A2	The wood structural panel sheathing and nailing are in adequate condition for use and the length provided is at least 50% of the length of each perimeter wall for a one-story dwelling, or at least 70% of the length of each perimeter wall for a two-story dwelling. Wood structural panels shall be attached with 8d common nails spaced 4 inches on center along each edge and 12 inches on center at each intermediate support.	Retrofit of sheathing is not required.	Retrofit of sheathing, anchorage to foundation, and connectors to dwelling above is required.	Provide detailed assessment or sheathing retrofit.
6	A3, B2	Anchor bolts are in adequate condition for use and are spaced at 64 inches on center maximum for a one-story dwelling, or 32 inches on center maximum for a two-story dwelling on average along each perimeter wall line.	Retrofit of anchorage to foundation is not required.	Retrofit of anchorage to foundation is required.	Provide detailed assessment or anchorage retrofit.

Note: For configuration illustrations see Figure 4.1-1 and Figure 4.1-2.

4.3.3 Detailed Assessment

Detailed assessment for foundations, foundation sill plate anchorage to the foundation, cripple wall sheathing, and anchorage of perimeter blocking or rim joists to the foundation sill plate or cripple top plates below, shall be in accordance with Sections 8.1 through 8.4.

4.3.4 Engineered Assessment

As an alternate to the detailed assessment requirements of Section 4.3.3 and Sections 8.1 through 8.4, an evaluation by a *registered design professional* can be provided to demonstrate that existing components are in compliance with this standard. This evaluation shall utilize all engineering criteria listed in Section 4.5. For guidance, assumptions made in developing the simplified engineered vulnerability-based retrofit in Section 4.5 are listed in the commentary for Section 4.5.

4.4 Prescriptive Vulnerability-Based Retrofit

4.4.1 Scope

Prescriptive retrofit provisions of this section are permitted for use on dwellings and *dwelling units* complying with the eligibility criteria of Table 4.1-1 and Table 4.1-2.

Dwellings identified by Section 4.3 to require foundation retrofit shall comply with Section 4.4.4.

Dwellings identified by Section 4.3 to require foundation sill plate anchorage retrofit shall comply with Section 4.4.5.

Dwellings identified by Section 4.3 to require retrofit of the connection to dwelling above shall comply with Section 4.4.8.

Dwellings identified by Section 4.3 to require retrofit of the cripple wall sheathing shall comply with the requirements of Section 4.4.4 through Section 4.4.10.

Where a dwelling's actual conditions require modification of the vulnerability-based prescriptive retrofit solutions identified within this section, additional or modified details may be generated by a *registered design professional* and used to supplement the prescriptive procedures of this section. These supplemental details shall bear the stamp and seal of the *registered design professional* in accordance with the statutes of the jurisdiction in which the retrofit is to be performed and *approved* by the *building official*.

All figures referenced in Section 4.4 describing the prescriptive retrofit provisions can be found at the end of Chapter 4.

4.4.2 Determination of Seismic Design Category

The prescriptive vulnerability-based retrofit procedures within Section 4.4 have been developed for dwellings located within Seismic Design Categories (SDCs) B to E. See Section 1.6 for S_{DS} values for use within this prescriptive procedure based upon the specific *Seismic Design Category*.

4.4.3 Determination of Weight Classification

The prescriptive vulnerability-based retrofit procedures of Section 4.4 have been developed for dwellings using three *weight classifications*: heavy, medium, and light construction. Further, eight weight combinations, based upon the type of exterior and interior wall finishes and roofing materials are assigned to three weight classifications as identified within Figure 4.4-1.

Where interior or exterior finishes vary, a heavier type finish shall be assumed where 25% or more of that finish type exists within the dwelling.

4.4.4 Foundations

Where identified by Section 4.3 to require retrofit, foundations shall be replaced with continuous perimeter foundations conforming to Figure 4.4-19.

4.4.5 Foundation Sill Plate Anchorage to the Foundation

Where identified by Section 4.3 to require retrofit, foundation sill plate anchorage shall be retrofitted in accordance with this section. Foundation sill plate anchorage of one of the types listed in Figure 4.4-2 or Figure 4.4-3 shall be provided at each perimeter wall in accordance with Figure 4.4-12 and Figure 4.4-13. The number of anchors per line shall be in accordance with the Earthquake Retrofit Schedules in Figures 4.4-6 through Figure 4.4-11, but not more than 64 inches on center for one-story dwellings and 48 inches on center for two-story dwellings and can be evenly distributed along each wall line.

4.4.6 Cripple Wall Sheathing

Where identified by Section 4.3 to require retrofit, cripple wall sheathing shall be retrofitted to conform to this section. *Cripple wall clear heights* greater than 7 feet are not permitted and not covered by this chapter. Cripple wall lengths and nailing shall be proportioned in two equal length panels per wall line where possible as indicated in the Earthquake Retrofit Schedules provided in Figure 4.4-6 through Figure 4.4-11 as applicable. Two panels of slightly different lengths can be used where obstructions prohibit equal length walls. If a single panel is used on a wall line instead of two panels, the minimum single panel length shall be two times the two panel length in the schedule reduced by 10%. If more than two panels are used, the total length of the two panels shall be increased 10% above the total panel length shown in the schedule. If panels of sufficient length with tie-downs cannot fit in the available wall length provided due to obstructions, the simplified engineering retrofit per Section 4.5 shall apply. In all cases, a fully sheathed wall line is deemed to comply with the bracing requirements within this standard.

Cripple walls sheathed with wood structural panels with or without tie-downs shall be provided at each perimeter wall line. Where tie-downs are used, the additional requirements of Section 4.4.7 shall apply. Wood structural panel bracing panels shall be provided in lengths not less than 4 feet. The length of

braced panels without tie-downs shall be equal to or exceed twice the height of the cripple wall.

Wood structural bracing panels shall be provided as close to each end of each perimeter wall line as possible.

Where tie-downs are not used, wood structural panel installation shall conform to Figure 4.4-16. Where tie-downs are used, wood structural panel installation shall conform to Figure 4.4-17.

4.4.7 Additional Requirements for Cripple Walls with Tie-Downs

Where tie-downs are used in conjunction with the Earthquake Retrofit Schedules in Figure 4.4-6 through 4.4-11, the additional requirements of Section 4.4.7.1 shall apply.

4.4.7.1 Existing Foundation Requirements

Where tie-downs are used, the foundation requirements of Section 4.4.7.2 shall be met. Where these requirements are not met, a new foundation system shall be required in accordance with Section 4.4.4 or engineered retrofit design shall be provided in accordance with Section 4.5.

4.4.7.2 Existing Foundation Visual Verification and Testing Requirements

Where tie-downs are used in accordance with the Earthquake Retrofit Schedules provided in Figure 4.4-6 through Figure 4.4-11, additional visual verification and testing of the existing foundation system is required to be completed by the owner or general contractor and *approved* by the *building official*.

4.4.7.2.1 Visual Verification

The size of existing foundation systems at the location of new tie-down anchors shall be verified to be at least 15 inches deep (“D”) and 8 inches wide (“W”). The dimension “D” shall be measured from the bottom of footing to the underside of the existing mudsill. The dimension “W” shall be measured from the top outside face of footing to the inside top face of footing as indicated in Figure 4.4-17.

4.4.7.2.2 Existing Foundation Quality Requirements

Verification of the overall quality of the concrete along any wall line requiring tie-downs shall be made by use of a minimum of two sacrificial torque tests along each wall line where tie-downs are used. These tests shall consist of installing 1/2- or 5/8-inch diameter threaded concrete anchors into the existing concrete and verifying that a torque value per Table 4.4-1 can be

achieved. Torque tests can be performed either by the owner, a general contractor, or a special inspection company or testing agency hired by the owner and as *approved* by the *building official*.

Table 4.4-1 Foundation Verification Requirements

Diameter	Screw Anchor Torque (ft-lbs.)	Adhesive Anchor Torque (ft-lbs.)
1/2"	35	15
5/8"	50	20

4.4.7.2.3 Existing Foundation Tension Test Requirements

Where “With Tie-downs” is specified within the Earthquake Retrofit Schedules in Figure 4.4-6 through Figure 4.4-11, each adhesive anchor shall be torque tested in accordance with Table 4.4-1. Torques in excess of those shown for adhesive anchors shall not be applied. Tests shall not be performed prior to adequate curing per manufacturer’s requirements. Anchors where torque tests fail shall be replaced and re-installed. Where torque tests continue to fail, the existing foundation system shall be replaced locally for a minimum of 30 inches on each side of the proposed tie-down anchor location.

4.4.7.2.4 Adhesive Anchor Installation Verification

Where “With Tie-downs” is specified within the Earthquake Retrofit Schedules in Figure 4.4-6 through Figure 4.4-11, installation shall conform to the manufacturer’s installation instructions. Items 1 through 10 below shall be performed and verified by the general contractor, owner, or shall be permitted to be verified by a special inspection company or testing agency hired by the owner and *approved* by the *building official*:

1. Drill all holes to the specified diameter and depth
2. Blow all holes clean of dust with oil-free compressed air for a minimum of 4 seconds
3. Clean all holes with a nylon or steel brush for a minimum of 4 cycles (per manufacturer’s instructions)
4. Blow holes clean of dust with oil-free compressed air for a minimum of 4 seconds
5. Check adhesive cartridge expiration date and required minimum temperature for adhesive cure
6. Open cartridge, connect the required nozzle, and install the cartridge in the dispensing tool

7. Purge out the required amount of adhesive to assure proper mixing per the manufacturer's instructions prior to filling any holes with adhesive
8. Fill the holes 1/2 to 2/3 full, starting at the bottom of the hole to prevent air pockets and withdraw the nozzle as the hole fills up
9. Insert a clean and oil-free anchor turning slowly until the anchor contacts the bottom of the hole
10. Do not disturb the anchor until adhesive has fully cured. See manufacturer's instructions for cure time required

Certification of installation and inspection shall be provided to *building official* when performed and verified by the general contractor, owner or when verified by a special inspection or testing agency prior to inspection by the jurisdiction and installation of sheathing.

4.4.7.3 Tie-Down Requirements

Tie-down requirements shall be as follows:

1. Tie-downs shall be as specified in Figure 4.4-4 and capable of developing 3,075 pounds based upon allowable stress design (ASD).
2. End studs(s) to which tie-downs are installed shall be 3× minimum or double 2× with nailing conforming to Figure 4.4-17.
3. All tie-downs shall use 5/8-inch diameter (A36) threaded rod adhesive-type anchors with minimum embedment per Figure 4.4-17.

4.4.8 Connection to Dwelling Above

Existing or new rim joists, blocking, and miscellaneous framing members shall be connected to the foundation sill or the top of cripple wall in accordance with Figures 4.4-13, Figure 4.4-14, and Figure 4.4-15, as required within the Earthquake Retrofit Schedules in Figure 4.4-6 through Figure 4.4-11, as applicable.

4.4.9 Additional Requirements for Non-Rectangular Dwellings with "T" or "L" Plan Configurations

Plan configurations other than rectangular such as "T" or "L" shapes that have offsets in the exterior wall lines, within the crawlspace plan area, greater than 33% of the largest plan dimension shall meet the following requirements in that direction:

- Foundation sill to foundation connections along offset walls shall have a maximum spacing of 32 inches on center.

- Floor joist to foundation sill and floor joist framing to the top of cripple wall connections along offset walls shall have a maximum spacing of 16 inches on center.
- Cripple walls, where they occur, shall be sheathed with new wood structural panels, as specified in Figure 4.4-16 or Figure 4.4-17. The sheathing shall have a minimum length of 90% of the offset wall length.

4.4.10 Special Provisions for One-Story Homes with Clay Tile Roofing

One story crawlspace dwellings with clay tile that weight up to 20 psf shall be permitted to be strengthened in accordance with the provisions for two-story heavy homes as noted in the applicable Earthquake Retrofit Schedules for an area twice the total area in square feet for any raised portion of the plan area.

4.5 Simplified Engineered Vulnerability-Based Retrofit

4.5.1 General

Engineered retrofit of foundations, foundation sill plate anchorage to the foundation, cripple wall sheathing, and anchorage of perimeter blocking or rim joists to the foundation sill plate or cripple wall top plates below shall be in accordance with the ASCE/SEI 7 Section 12.14, Simplified Alternative Structural Design Criteria for Simple Bearing Wall or Building Frame Systems, as amended below. Material design capacities for all components shall be as specified by the adopted building code.

1. The scope of seismic retrofit need only include the foundations, foundation sill plate anchorage to the foundation, cripple wall sheathing, and anchorage of perimeter blocking or rim joists to the foundation sill plate or cripple wall top plates below.
2. ASCE/SEI 7 Section 12.14 shall be modified as described in Table 4.5-1. ASCE/SEI 7 section may either be applicable as written (Y) with or without notes; not applicable (N); or applicable with clarifications noted (M).
3. Cripple wall wood structural panel sheathing and seismic load path shall be designed using a seismic response modification factor, R , of 4.0.
4. Finish and bracing materials other than wood structural panels (per definitions in Chapter 2) shall not be considered to provide seismic capacity in the crawlspace.
5. The in-plane *load path connections* for anchorage to foundations and anchorage to floor framing above shall be provided at all locations where retrofit cripple wall sheathing is provided. In-plane load path

connections shall be designed using load combinations with an overstrength factor, Ω_0 , of 1.5 in lieu of 2.5 in ASCE/SEI 7 Section 12.14.3.2.

6. Where tie-downs are used in the existing foundation, the *registered design professional* shall be responsible for evaluating the existing foundation system.

Table 4.5-1 ASCE/SEI 7 Section 12.14 Application Matrix

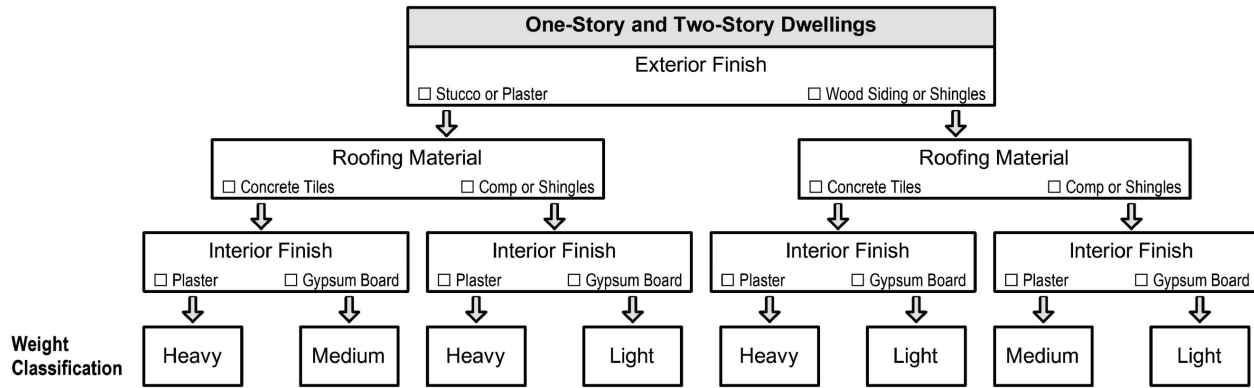
ASCE/SEI 7 Section	Applicability	Notes
12.14.1.1	N	All limitations listed within Items 1 through 12 shall be assumed to comply and ASCE/SEI 7 Section 12.14 is eligible for use
12.14.1.2	Y	
12.14.1.3	M	See Chapter 3 for additional definitions
12.14.1.4	M	Notations as applicable
12.14.2	M	See Section 4.5.1 Item 1
12.14.3	M	See Section 4.5.1 Item 1
12.14.3.1	Y	
12.14.3.2	M	E_{mh} shall be taken as $1.5Q_E$
12.14.4.1	N	
12.14.4.2	N	
12.14.5	M	See Section 4.5.2 Item 2
12.14.6	Y	
12.14.7	N	
12.14.8.1	M	$F = 1.0$ for two-story dwellings
12.14.8.2	Y	
12.14.8.3	Y	
12.14.8.3.1	M	See Section 4.5.2 Item 2
12.14.8.3.2	N	
12.14.8.3.2.1	N	
12.14.8.4	N	
12.14.8.5	N	

4.5.2 Additional Simplifying Assumptions

The following simplifications shall be permitted to be made in the engineered retrofit design:

1. Where applicable, the unit assembly weights listed in non-mandatory Appendix L of this standard are permitted to be used for determination of the seismic base shear.

2. In lieu of a horizontal force distribution in accordance with ASCE/SEI 7 Section 12.14.8, seismic forces may be distributed equally to each exterior wall line in each orthogonal direction, except as follows:
 - a. Plan configurations other than rectangular such as “T” or “L” shapes that have offsets in the exterior wall lines, within the crawlspace plan area, greater than 33% of the largest plan dimension in each direction shall have seismic forces distributed to that exterior wall lines based upon rational analysis assuming relative diaphragm in-plane flexibility.
 - b. Where exterior walls of plan configurations other than rectangular such as “T” or “L” shapes have offset walls along the same orthogonal direction offset by less than 33%, the distribution of seismic forces may be assumed to be proportional to the length of each of the exterior wall segments.
3. When designing cripple walls for overturning, in lieu of a more detailed overturning analysis of the entire dwelling, each exterior cripple wall line shall be designed to resist its local overturning moment plus 15 percent of the total overturning moment of the superstructure above. The calculations of forces F_R and F_{2nd} (where applicable) can be based upon tributary mass to those levels per ASCE/SEI 7 Section 12.14.13.
4. The allowable tension load at the end of cripple walls braced with wood structural panels can be assumed as follows:
 - a. Where two *post-installed anchor* bolts are installed at each end of cripple walls braced with wood structural panels as indicated in Figure 4.4-16, the allowable tension load may be assumed to have an allowable uplift capacity of 1.5 kips (ASD) provided there is a minimum length to height ratio of 2.0 for the sheathed portion of the cripple wall.
 - b. Where one *post-installed anchor* bolt and one tie-down anchor are installed at each end of cripple walls braced with wood structural panels as indicated Figure 4.4-17, the end of the wall may be assumed to have an allowable uplift capacity of 3.0 kips (ASD).
5. Soil *site class* may be assumed to be type C if specific site class information is not available.



Weight Classification:

This flowchart is used to determine the general weight classification of your home's construction.

1. Check the box of the material that most closely matches your home's finishes.
2. Note the Weight Classification result for use in the Earthquake Retrofit Schedules.

Specific notes for exterior, interior and roof coverings

1. The "wood siding or shingles" exterior finish category also includes finishes of similar weight, including but not limited to fiber-cement and aluminum siding.
2. The "comp or shingles" roofing material category also includes roofing materials of similar weight, including but not limited to roll roofing, built-up felt roofing, single-ply membrane roofing, and metal roofing.
3. The "gypsum board" interior finish category also includes wall finish materials of similar weight, including but not limited to wood board or panel siding.
4. The exterior finish, roofing material and interior finish categories are intended to be identified based on the predominant materials used in construction.

Figure 4.4-1 Dwelling weight classification by interior and exterior finishes. Sheet S3.

ANCHOR BOLTS			
IMAGE	TYPE	EMBEDMENT DEPTH	
		1/2"Ø	5/8"Ø
	Screw-Type Anchor	4-1/2"	4-1/2"
	Adhesive-Type Anchor	4-1/4"	5"

Figure 4.4-3 Foundation sill anchors. Sheet S3.

TIE-DOWNS			
Supplemental Technical Notes, Sheet S2, Section T			
IMAGE	TYPE	SHEET REF	CAPACITY (ASD)
	Wood Stud to Foundation Tension Tie	SHEET D4	3000#

Figure 4.4-4 Tie-down requirements. Sheet S3.

CONNECTORS			
IMAGE	TYPE	SHEET REF	MIN CAPACITY (lbs) ASD
	A	Foundation Sill to Foundation	1530
	B		960
	C		875

Figure 4.4-2 Foundation sill anchors. Sheet S3.

	D	Floor to Cripple Wall or Floor to Foundation Sill	565
	E		740
	F		590
	G		445
	H		725

Figure 4.4-5 Floor to cripple wall or foundation sill connectors. Sheet S3.

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.0$ Seismic) ONE-STORY																			
Weight Category	Total Area in Square Feet	Mark row that applies	Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length								
			Wood Structural Panels										Foundation Sill Anchors			Floor to Cripple Wall or Floor to Foundation Sill			
			Cripple Wall Height								Panel Edge Nailing								
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"	4'-1" to 6'-0"	6'-1" to 7'-0"	Without Tie-downs	With Tie-downs	Without Tie-downs		With Tie-downs	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"
1-Story Light Construction	up to 800	<input type="checkbox"/>	5.3'	5.3'	8.0'	5.3'	9.3'	5.3'	9.3'	6.7'	4"	4	7	7	7	5	11	10	14
	801 to 1000	<input type="checkbox"/>	6.7'	6.7'	8.0'	6.7'	10.7'	6.7'	10.7'	8.0'	4"	5	8	8	8	6	13	12	16
	1001 to 1200	<input type="checkbox"/>	6.7'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	4"	6	9	10	10	7	15	14	19
	1201 to 1500	<input type="checkbox"/>	8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	13.3'	9.3'	4"	7	11	12	12	8	18	17	22
	1501 to 2000	<input type="checkbox"/>	9.3'	10.7'	13.3'	10.7'	14.7'	10.7'	16.0'	12.0'	4"	9	14	15	15	10	23	22	29
	2001 to 2500	<input type="checkbox"/>	12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	18	18	12	27	26	35
	2501 to 3000	<input type="checkbox"/>	14.7'	14.7'	16.0'	14.7'	18.7'	14.7'	20.0'	16.0'	4"	12	19	21	21	14	32	31	40
1-Story Medium Construction	up to 800	<input type="checkbox"/>	5.3'	6.7'	8.0'	5.3'	9.3'	6.7'	10.7'	6.7'	3"	5	8	8	8	6	13	12	16
	801 to 1000	<input type="checkbox"/>	5.3'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	3"	6	9	10	10	7	15	14	19
	1001 to 1200	<input type="checkbox"/>	6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	3"	7	10	11	11	8	17	17	22
	1201 to 1500	<input type="checkbox"/>	8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	3"	8	12	13	13	9	20	20	26
	1501 to 2000	<input type="checkbox"/>	9.3'	10.7'	13.3'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	10	15	17	17	11	25	24	32
	2001 to 2500	<input type="checkbox"/>	10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	13.3'	3"	12	18	20	20	14	30	29	38
	2501 to 3000	<input type="checkbox"/>	12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	3"	13	21	23	23	16	35	34	45
1-Story Heavy Construction	up to 800	<input type="checkbox"/>	5.3'	6.7'	8.0'	5.3'	10.7'	6.7'	10.7'	8.0'	2"	6	9	10	10	7	15	14	18
	801 to 1000	<input type="checkbox"/>	6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	2"	7	10	11	11	8	17	17	22
	1001 to 1200	<input type="checkbox"/>	6.7'	8.0'	10.7'	8.0'	12.0'	9.3'	13.3'	10.7'	2"	8	12	13	13	9	20	19	25
	1201 to 1500	<input type="checkbox"/>	8.0'	9.3'	12.0'	9.3'	14.7'	10.7'	14.7'	12.0'	2"	9	14	15	15	11	24	23	30
	1501 to 2000	<input type="checkbox"/>	9.3'	10.7'	14.7'	10.7'	16.0'	12.0'	17.3'	13.3'	2"	11	18	19	19	13	30	29	38
	2001 to 2500	<input type="checkbox"/>	10.7'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	36	34	45
	2501 to 3000	<input type="checkbox"/>	12.0'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	17.3'	2"	16	25	27	27	18	41	40	53

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that one additional anchor is required at the end of each braced wall panel per Sheet S4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the [redacted] listed [redacted] capacity [redacted]. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-6 Earthquake retrofit schedule, $S_{DS} = 1.0$, one story. Sheet S3.1-1.

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.2$ High Seismic) ONE-STORY																					
Weight Category	Total Area in Square Feet	Mark row that applies <input checked="" type="checkbox"/>	Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length										
			Wood Structural Panels										Foundation Sill Anchors				Floor to Cripple Wall or Floor to Foundation Sill				
			Cripple Wall Height										Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2" Bolt	5/8" Bolt	Type "D"	Type "E" or "F"	Type "G"
			up to 1'		1'-1" to 2'		2'-1" to 4'-0"		4'-1" to 6'-0"		6'-1" to 7'-0"										
			Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs											
1-Story Light Construction	up to 800		6.7'	6.7'	8.0'	6.7'	10.7'	6.7'	10.7'	8.0'	4"	5	8	8	8	6	13	12	16		
	801 to 1000		6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	8.0'	4"	6	9	10	10	7	15	15	19		
	1001 to 1200		8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	13.3'	9.3'	4"	7	11	12	12	8	18	17	22		
	1201 to 1500		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	10.7'	4"	8	13	14	14	10	21	20	27		
	1501 to 2000		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	18	18	12	27	26	34		
	2001 to 2500		14.7'	14.7'	17.3'	14.7'	20.0'	14.7'	21.3'	16.0'	4"	12	19	21	21	15	33	31	41		
	2501 to 3000		17.3'	17.3'	18.7'	17.3'	21.3'	17.3'	22.7'	17.3'	4"	14	23	25	25	17	38	37	48		
1-Story Medium Construction	up to 800		5.3'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	3"	6	9	10	10	7	15	15	19		
	801 to 1000		6.7'	8.0'	10.7'	6.7'	12.0'	8.0'	13.3'	9.3'	3"	7	11	12	12	8	18	17	23		
	1001 to 1200		8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	3"	8	12	13	13	9	21	20	26		
	1201 to 1500		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	9	15	16	16	11	24	23	31		
	1501 to 2000		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	39		
	2001 to 2500		13.3'	13.3'	17.3'	13.3'	20.0'	14.7'	21.3'	16.0'	3"	14	22	24	24	16	36	35	46		
	2501 to 3000		14.7'	14.7'	18.7'	14.7'	21.3'	17.3'	22.7'	18.7'	3"	16	25	27	27	19	42	40	53		
1-Story Heavy Construction	up to 800		6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	2"	7	10	11	11	8	17	17	22		
	801 to 1000		6.7'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	2"	8	12	14	13	9	21	20	26		
	1001 to 1200		8.0'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	2"	9	14	16	15	11	24	23	30		
	1201 to 1500		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	2"	11	17	18	18	13	28	27	36		
	1501 to 2000		10.7'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	36	34	45		
	2001 to 2500		13.3'	14.7'	18.7'	13.3'	21.3'	16.0'	22.7'	17.3'	2"	16	25	28	28	19	43	41	54		
	2501 to 3000		14.7'	16.0'	20.0'	16.0'	22.7'	18.7'	25.3'	20.0'	2"	19	29	32	32	22	50	48	63		

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that one additional anchor is required at the end of each braced wall panel per Sheet S4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the [redacted] listed [redacted] capacity [redacted] group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-7 Earthquake retrofit schedule, $S_{DS} = 1.2$, one story. Sheet S3.1-2.

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.5$ Very High Seismic) ONE-STORY																			
Weight Category	Total Area in Square Feet	Mark row that applies <input checked="" type="checkbox"/>	Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length								
			Wood Structural Panels								Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill			
			Cripple Wall Height																
			up to 1' Without Tie-downs	1'-1" to 2' Without Tie-downs	2'-1" to 4'-0" Without Tie-downs		4'-1" to 6'-0" Without Tie-downs		6'-1" to 7'-0" Without Tie-downs		Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
1-Story Light Construction	up to 800		8.0'	8.0'	10.7'	8.0'	12.0'	8.0'	13.3'	9.3'	4"	6	10	10	10	7	16	15	20
	801 to 1000		9.3'	9.3'	12.0'	9.3'	13.3'	9.3'	14.7'	10.7'	4"	7	11	12	12	9	19	18	24
	1001 to 1200		10.7'	10.7'	13.3'	10.7'	16.0'	10.7'	16.0'	12.0'	4"	8	13	14	14	10	22	21	28
	1201 to 1500		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	17	17	12	26	25	33
	1501 to 2000		14.7'	14.7'	17.3'	14.7'	21.3'	16.0'	22.7'	16.0'	4"	13	20	22	22	15	34	32	43
	2001 to 2500		18.7'	18.7'	20.0'	18.7'	24.0'	18.7'	25.3'	18.7'	4"	15	24	27	27	18	41	39	52
	2501 to 3000		21.3'	21.3'	22.7'	21.3'	26.7'	21.3'	28.0'	21.3'	4"	18	28	31	31	21	48	46	60
1-Story Medium Construction	up to 800		6.7'	8.0'	10.7'	6.7'	13.3'	9.3'	13.3'	9.3'	3"	7	11	12	12	9	19	18	24
	801 to 1000		8.0'	9.3'	12.0'	8.0'	14.7'	10.7'	16.0'	10.7'	3"	9	13	15	15	10	22	21	28
	1001 to 1200		9.3'	10.7'	13.3'	9.3'	16.0'	12.0'	17.3'	12.0'	3"	10	15	17	17	11	26	25	32
	1201 to 1500		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	38
	1501 to 2000		13.3'	13.3'	17.3'	13.3'	21.3'	16.0'	22.7'	17.3'	3"	14	23	25	25	17	38	36	48
	2001 to 2500		16.0'	16.0'	20.0'	16.0'	22.7'	17.3'	25.3'	20.0'	3"	17	27	29	29	20	45	43	57
	2501 to 3000		18.7'	18.7'	21.3'	18.7'	25.3'	20.0'	26.7'	21.3'	3"	20	31	34	34	23	53	50	67
1-Story Heavy Construction	up to 800		8.0'	9.3'	12.0'	8.0'	13.3'	10.7'	14.7'	10.7'	2"	8	13	14	14	10	22	21	27
	801 to 1000		8.0'	10.7'	13.3'	9.3'	16.0'	12.0'	17.3'	12.0'	2"	10	15	17	17	11	26	25	33
	1001 to 1200		9.3'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	13.3'	2"	11	18	19	19	13	30	28	37
	1201 to 1500		10.7'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	35	34	45
	1501 to 2000		13.3'	16.0'	18.7'	14.7'	22.7'	17.3'	24.0'	18.7'	2"	17	26	29	29	20	44	43	56
	2001 to 2500		14.7'	17.3'	21.3'	16.0'	25.3'	20.0'	26.7'	21.3'	2"	20	32	35	34	24	53	51	67
	2501 to 3000		17.3'	20.0'	24.0'	18.7'	28.0'	22.7'	29.3'	24.0'	2"	23	37	40	40	27	62	59	79

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that one additional anchor is required at the end of each braced wall panel per Sheet S4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the listed capacity. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-8 Earthquake retrofit schedule, $S_{DS} = 1.5$, one story. Sheet S3.1-3.

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.0$ Seismic) TWO-STORY																											
Weight Category	Total Area in Square Feet	Mark row that applies <input checked="" type="checkbox"/>	Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length																
			Wood Structural Panels										Foundation Sill Anchors				Floor to Cripple Wall or Floor to Foundation Sill										
			Cripple Wall Height								Panel Edge Nailing	Type "A"		Type "B"		Type "C"		1/2"Ø Bolt		5/8"Ø Bolt		Type "D"		Type "E" or "F"		Type "G"	
			up to 1'		1'-1" to 2'		2'-1" to 4'-0"		4'-1" to 6'-0"			6'-1" to 7'-0"		Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Type "D"	Type "E" or "F"	Type "G"			
2-Story Light Construction	up to 1600		8.0'	8.0'	10.7'	8.0'	12.0'	9.3'	13.3'	9.3'	4"	7	10	11	11	8	17	17	22								
	1601 to 2000		9.3'	9.3'	12.0'	9.3'	13.3'	10.7'	14.7'	10.7'	4"	8	12	13	13	9	20	19	26								
	2001 to 2400		10.7'	10.7'	13.3'	10.7'	14.7'	10.7'	16.0'	12.0'	4"	9	14	15	15	10	23	22	29								
	2401 to 3000		12.0'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	13.3'	4"	10	16	18	18	12	27	26	34								
	3001 to 4000		14.7'	14.7'	17.3'	16.0'	20.0'	16.0'	21.3'	16.0'	4"	13	20	22	22	15	34	32	43								
2-Story Medium Construction	up to 1600		8.0'	9.3'	10.7'	8.0'	13.3'	9.3'	13.3'	10.7'	3"	7	11	12	12	9	19	18	24								
	1601 to 2000		9.3'	10.7'	12.0'	9.3'	14.7'	10.7'	14.7'	12.0'	3"	9	13	15	15	10	22	22	28								
	2001 to 2400		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	16.0'	13.3'	3"	10	15	17	17	11	26	25	32								
	2401 to 3000		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	39								
	3001 to 4000		13.3'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	17.3'	3"	14	23	25	25	17	38	36	48								
2-Story Heavy Construction	up to 1600		9.3'	9.3'	12.0'	9.3'	13.3'	10.7'	14.7'	12.0'	2"	9	14	16	16	11	24	23	30								
	1601 to 2000		9.3'	10.7'	13.3'	10.7'	14.7'	12.0'	16.0'	13.3'	2"	11	17	18	18	13	28	27	35								
	2001 to 2400		10.7'	12.0'	14.7'	10.7'	16.0'	13.3'	17.3'	14.7'	2"	12	19	21	21	14	32	31	41								
	2401 to 3000		12.0'	13.3'	16.0'	13.3'	18.7'	14.7'	18.7'	16.0'	2"	14	23	25	25	17	38	37	48								
	3001 to 4000		13.3'	16.0'	18.7'	14.7'	21.3'	17.3'	22.7'	18.7'	2"	18	28	31	31	21	48	46	60								

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that one additional anchor is required at the end of each braced wall panel per Sheet S4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the listed capacity. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-9 Earthquake retrofit schedule, $S_{DS} = 1.0$, two story. Sheet S3.1-4.

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.2$ High Seismic) TWO-STORY																				
Weight Category	Total Area in Square Feet	Mark row that applies <input checked="" type="checkbox"/>	Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length									
			Wood Structural Panels										Foundation Sill Anchors				Floor to Cripple Wall or Floor to Foundation Sill			
			Cripple Wall Height								Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"	
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"	4'-1" to 6'-0"	6'-1" to 7'-0"	Without Tie-downs	With Tie-downs	Without Tie-downs										With Tie-downs
2-Story Light Construction	up to 1600		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	4"	8	12	13	13	9	21	20	26	
	1601 to 2000		10.7'	10.7'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	4"	9	14	16	16	11	24	23	31	
	2001 to 2400		12.0'	12.0'	14.7'	13.3'	17.3'	13.3'	18.7'	14.7'	4"	10	16	18	18	12	28	26	35	
	2401 to 3000		14.7'	14.7'	16.0'	14.7'	20.0'	14.7'	20.0'	16.0'	4"	12	19	21	21	14	33	31	41	
	3001 to 4000		17.3'	18.7'	18.7'	18.7'	22.7'	18.7'	24.0'	18.7'	4"	15	24	26	26	18	40	39	51	
2-Story Medium Construction	up to 1600		9.3'	10.7'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	9	14	15	15	10	23	22	29	
	1601 to 2000		10.7'	12.0'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	3"	10	16	18	17	12	27	26	34	
	2001 to 2400		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	31	29	39	
	2401 to 3000		13.3'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	16.0'	3"	14	22	24	24	16	36	35	46	
	3001 to 4000		16.0'	16.0'	20.0'	16.0'	22.7'	18.7'	24.0'	20.0'	3"	17	27	30	29	20	46	44	58	
2-Story Heavy Construction	up to 1600		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	16.0'	13.3'	2"	11	17	19	18	13	28	27	36	
	1601 to 2000		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	2"	13	20	22	22	15	34	32	42	
	2001 to 2400		12.0'	13.3'	16.0'	13.3'	18.7'	14.7'	20.0'	16.0'	2"	15	23	25	25	17	38	37	49	
	2401 to 3000		13.3'	14.7'	18.7'	14.7'	21.3'	17.3'	21.3'	18.7'	2"	17	27	30	29	20	46	44	58	
	3001 to 4000		16.0'	17.3'	21.3'	17.3'	24.0'	20.0'	25.3'	21.3'	2"	21	34	37	37	25	57	55	72	

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that one additional anchor is required at the end of each braced wall panel per Sheet S4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the listed capacity group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-10 Earthquake retrofit schedule, $S_{DS} = 1.2$, two story. Sheet S3.1-5.

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS}= 1.5$ Very High Seismic) TWO-STORY																				
Weight Category	Total Area in Square Feet	<input checked="" type="checkbox"/> Mark row that applies	Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length									
			Wood Structural Panels										Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill		
			Cripple Wall Height								Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"	
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"		4'-1" to 6'-0"		6'-1" to 7'-0"											
Without Tie-downs	Without Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs											
2-Story Light Construction	up to 1600		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	15	17	17	11	26	25	32	
	1601 to 2000		13.3'	13.3'	16.0'	13.3'	18.7'	14.7'	20.0'	16.0'	4"	11	18	20	19	13	30	29	38	
	2001 to 2400		14.7'	16.0'	17.3'	16.0'	21.3'	16.0'	22.7'	17.3'	4"	13	20	22	22	15	34	33	43	
	2401 to 3000		18.7'	18.7'	20.0'	18.7'	22.7'	18.7'	24.0'	18.7'	4"	15	24	26	26	18	41	39	51	
	3001 to 4000		22.7'	22.7'	22.7'	22.7'	26.7'	24.0'	28.0'	24.0'	4"	19	30	33	33	22	50	48	64	
2-Story Medium Construction	up to 1600		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	11	17	18	18	13	28	27	36	
	1601 to 2000		12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	3"	13	20	22	22	15	33	32	42	
	2001 to 2400		13.3'	14.7'	18.7'	13.3'	21.3'	16.0'	22.7'	17.3'	3"	14	23	25	25	17	38	37	48	
	2401 to 3000		16.0'	17.3'	20.0'	16.0'	22.7'	18.7'	24.0'	20.0'	3"	17	27	29	29	20	45	43	58	
	3001 to 4000		20.0'	20.0'	22.7'	20.0'	26.7'	21.3'	28.0'	22.7'	3"	21	34	37	37	25	57	54	72	
2-Story Heavy Construction	up to 1600		12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	35	34	45	
	1601 to 2000		13.3'	14.7'	17.3'	14.7'	20.0'	16.0'	21.3'	17.3'	2"	16	25	27	27	19	42	40	53	
	2001 to 2400		14.7'	16.0'	20.0'	16.0'	22.7'	18.7'	24.0'	18.7'	2"	18	28	31	31	21	48	46	61	
	2401 to 3000		16.0'	18.7'	21.3'	17.3'	24.0'	20.0'	25.3'	21.3'	2"	21	34	37	37	25	57	55	72	
	3001 to 4000		18.7'	21.3'	25.3'	20.0'	28.0'	24.0'	29.3'	25.3'	2"	27	42	46	46	31	71	68	90	

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that one additional anchor is required at the end of each braced wall panel per Sheet S4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the [redacted] listed [redacted] capacity [redacted]. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-11 Earthquake retrofit schedule, $S_{DS} = 1.5$, two story. Sheet S3.1-6.

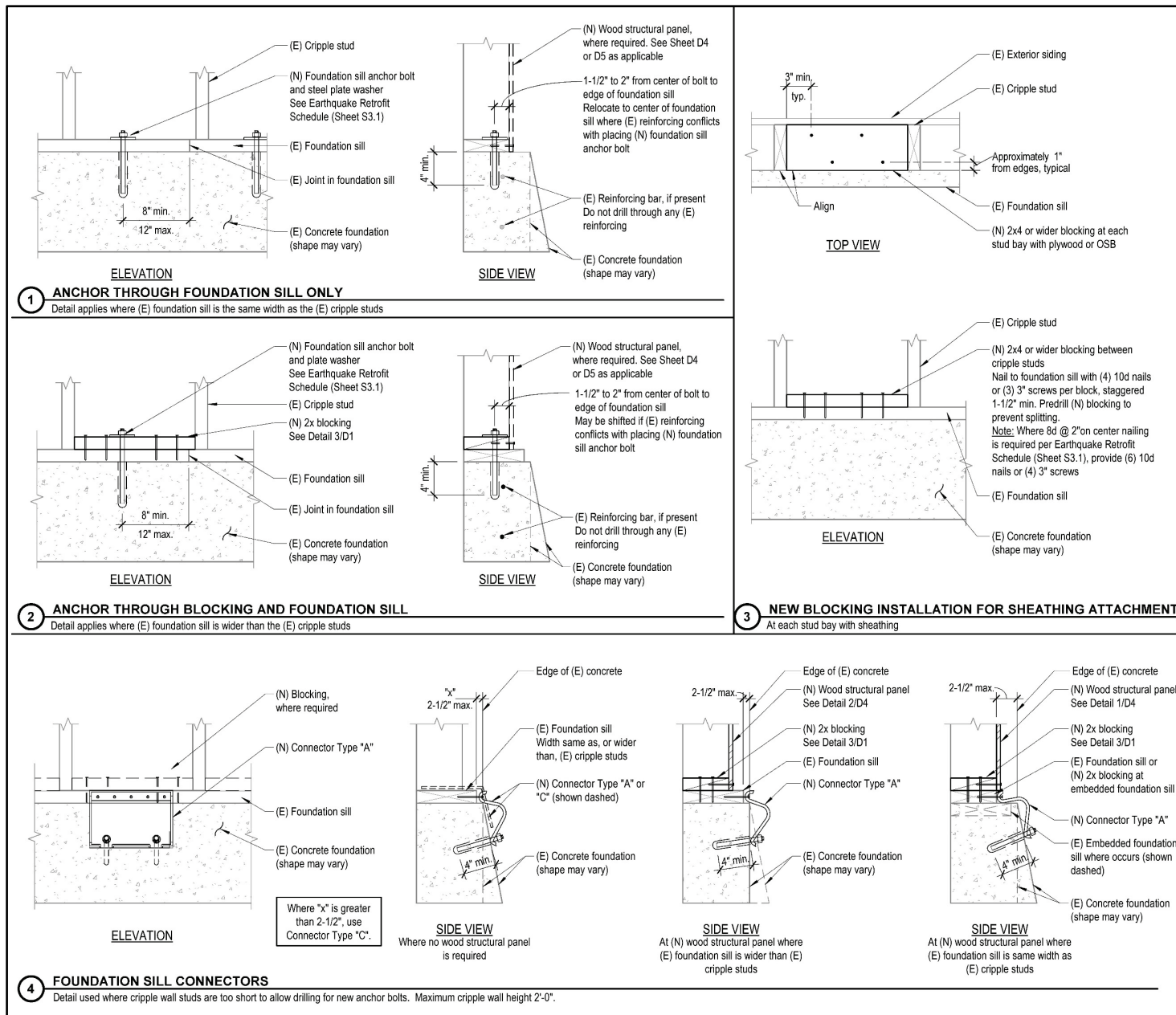


Figure 4.4-12 Foundation sill to concrete foundation connection details. Sheet D1.

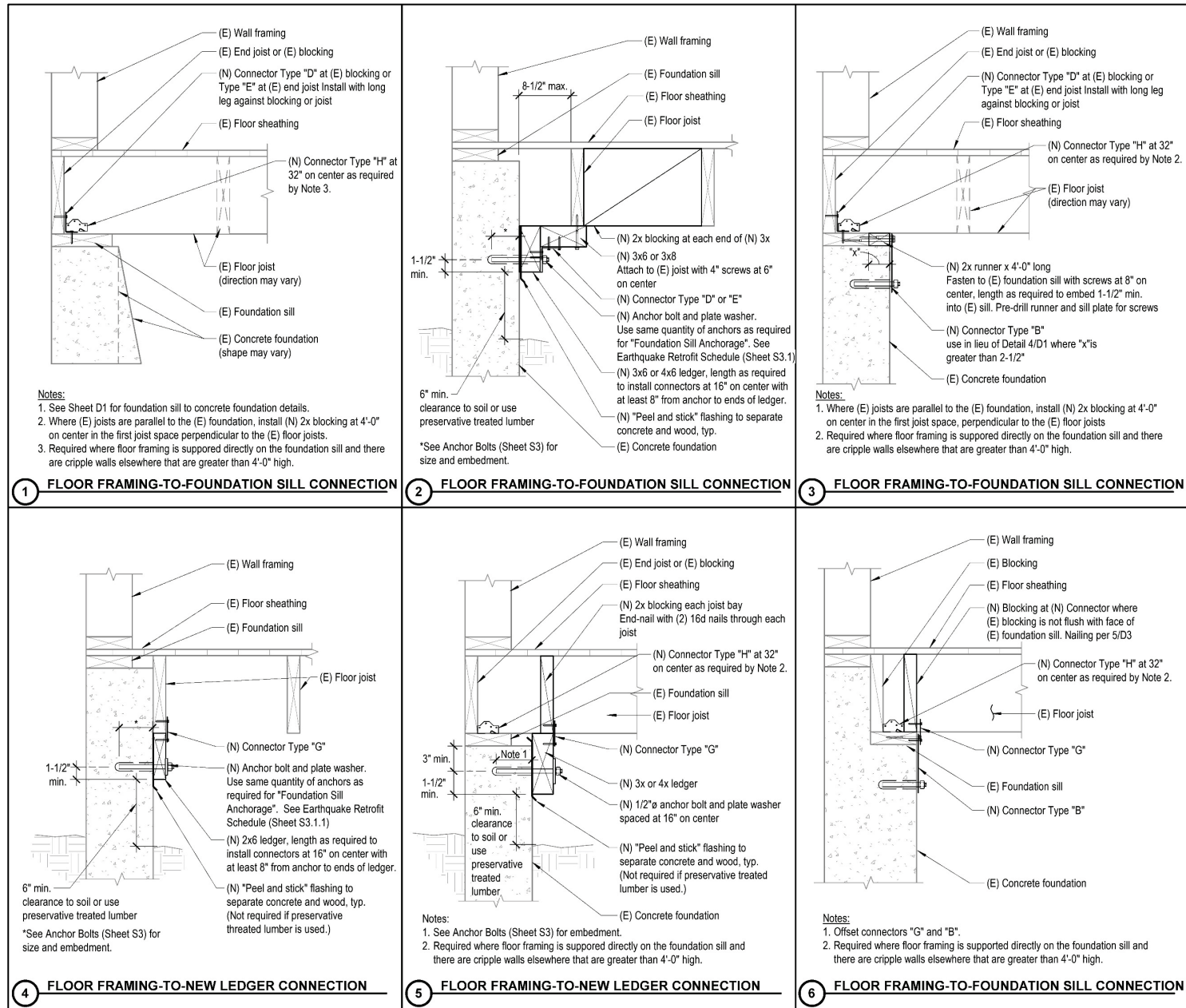


Figure 4.4-13 Floor framing to foundation sill connection details. Sheet D2.

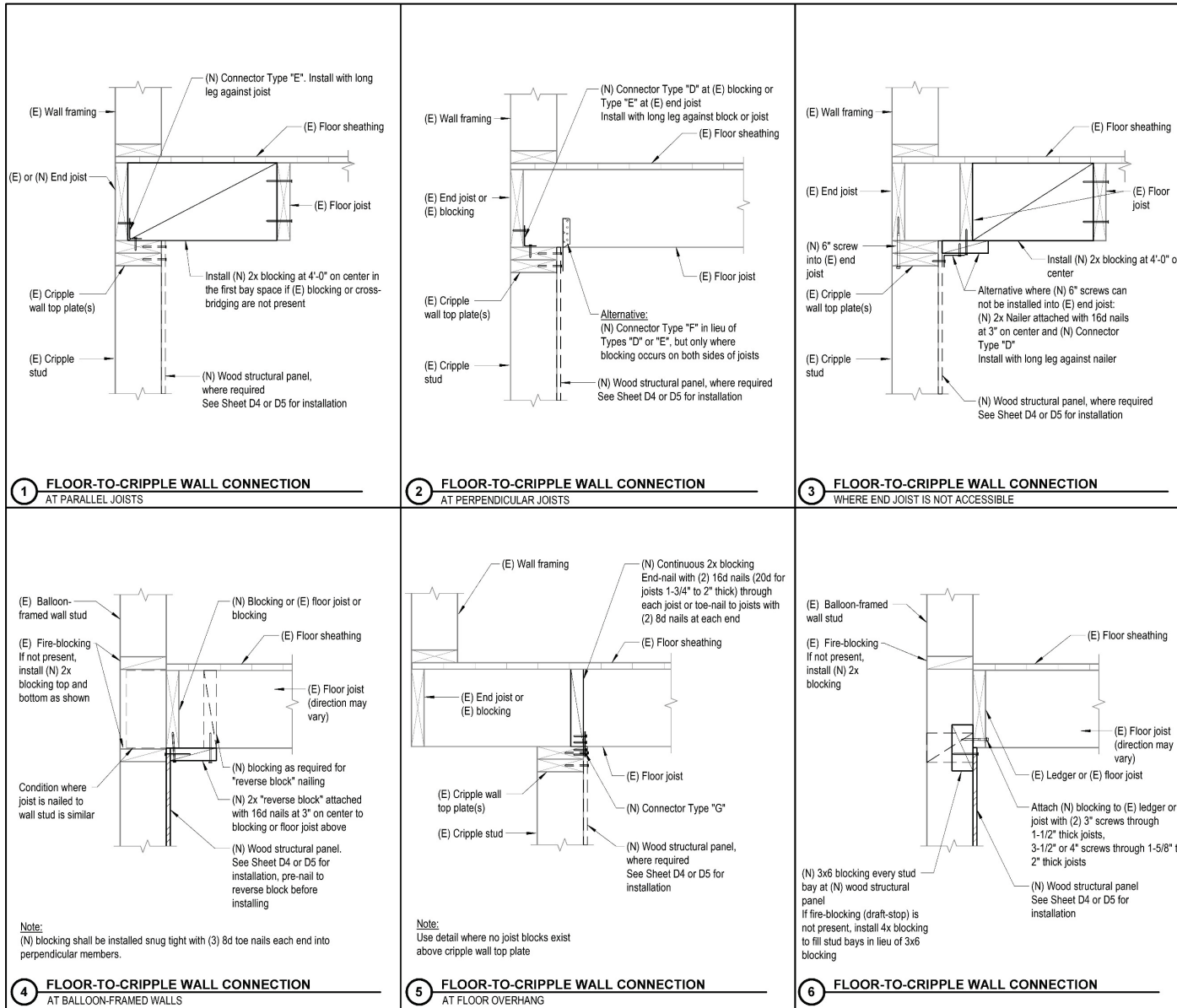


Figure 4.4-14 Floor framing to cripple wall connection details. Sheet D3.

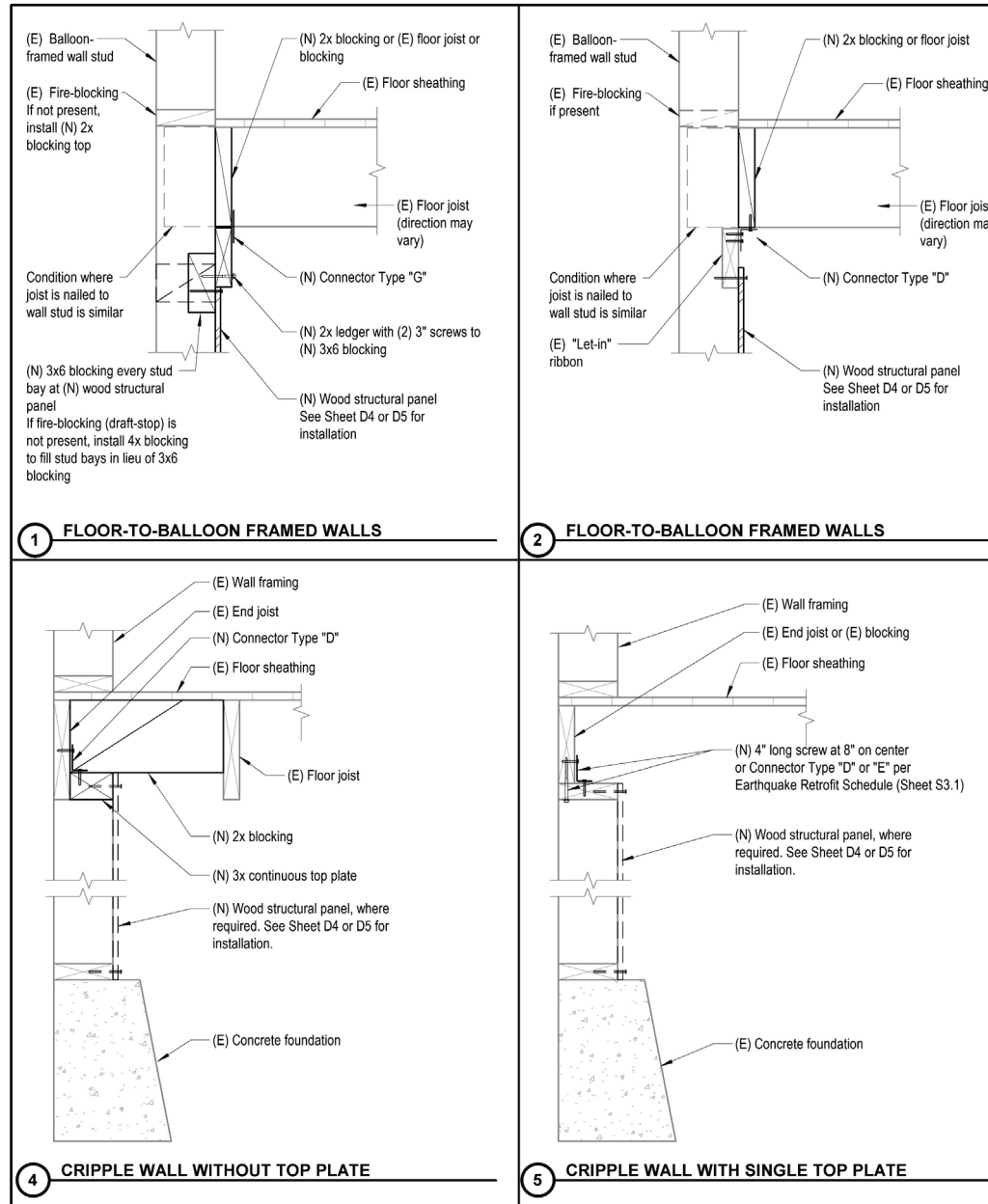


Figure 4.4-15 Floor framing to cripple wall connection details. Sheet D3.1.

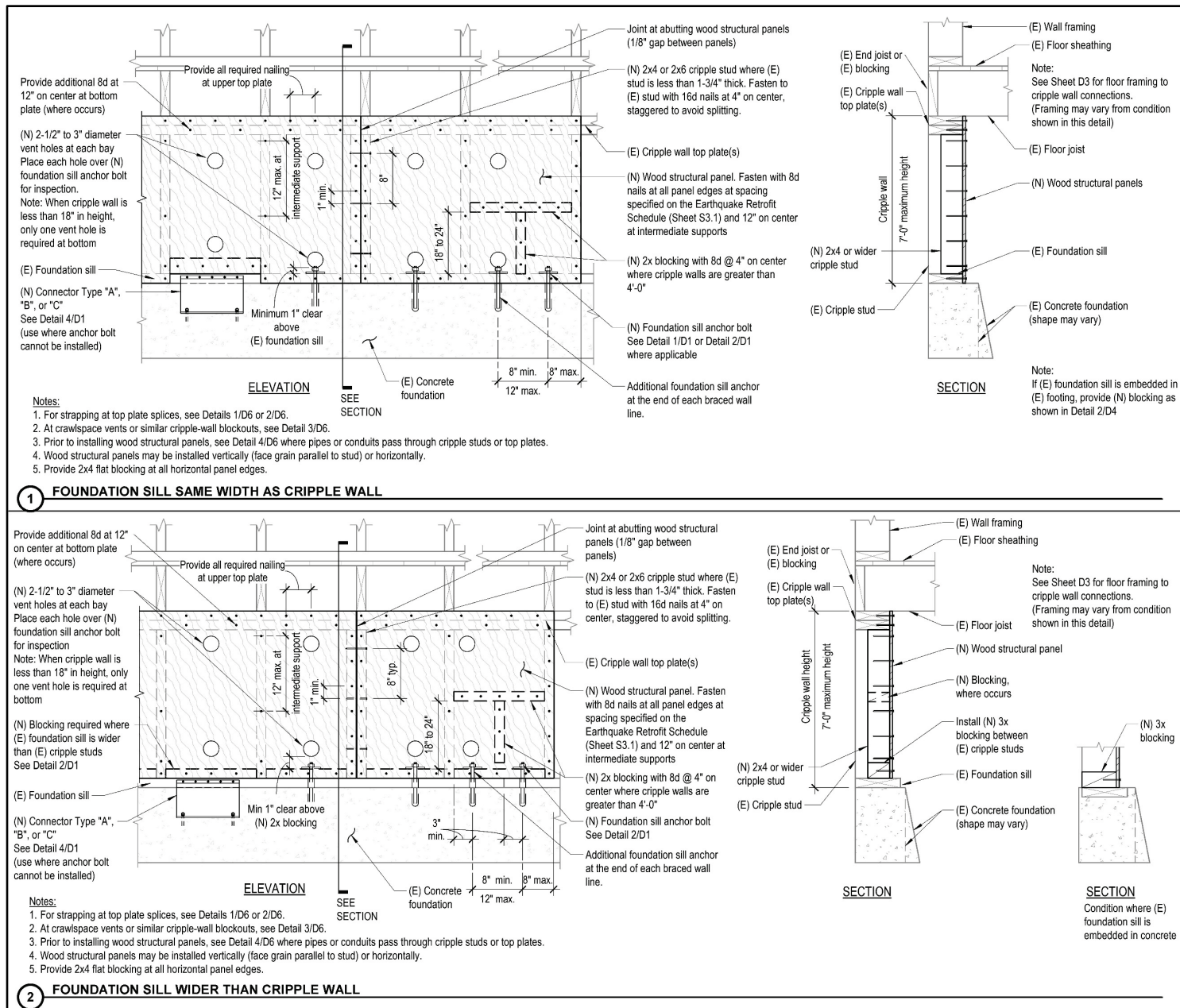


Figure 4.4-16 Wood structural panel installation without tie-downs. Sheet D4.

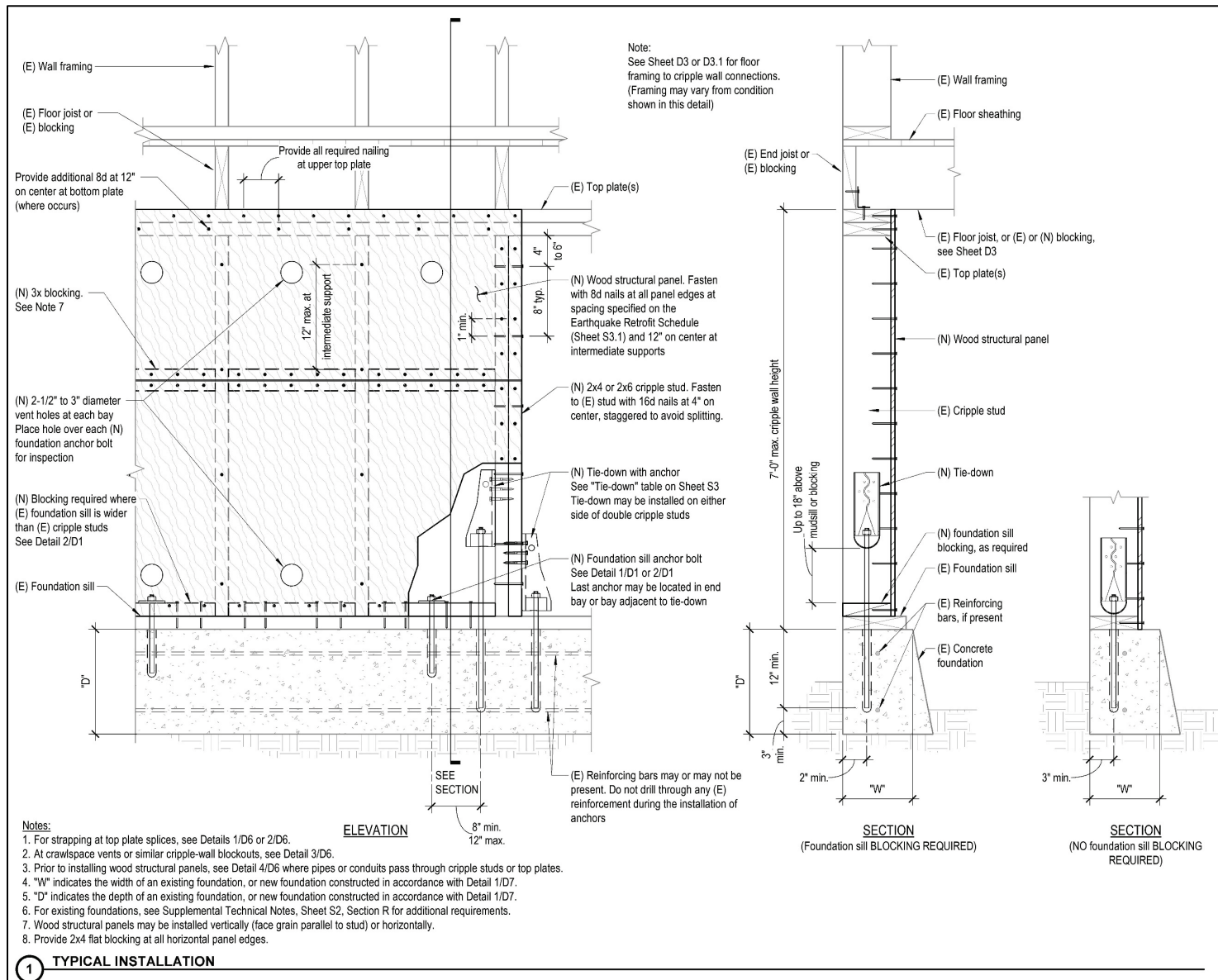


Figure 4.4-17 Wood structural panel installation with tie-downs. Sheet D5.

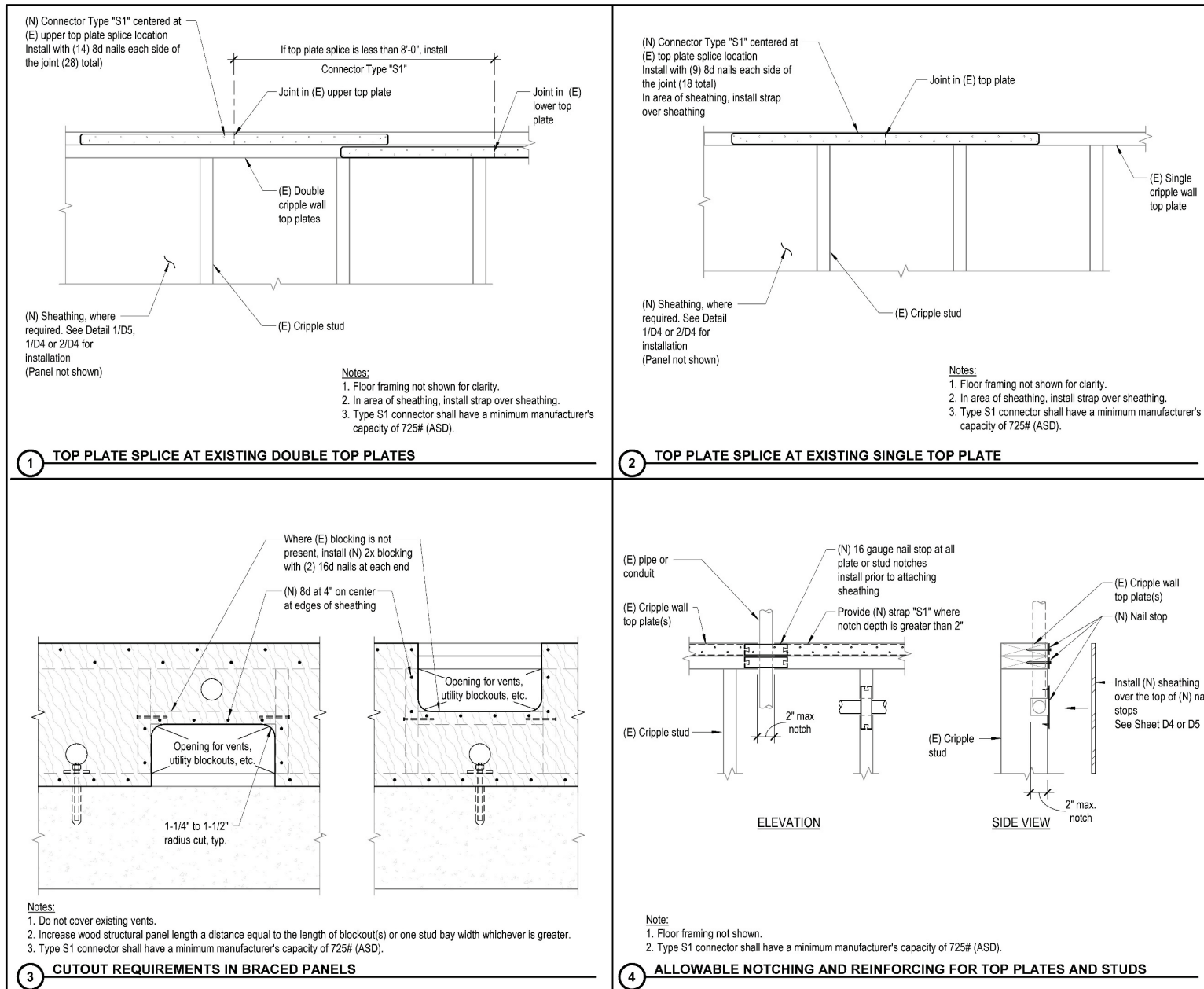


Figure 4.4-18 Vent openings and top plate details. Sheet D6.

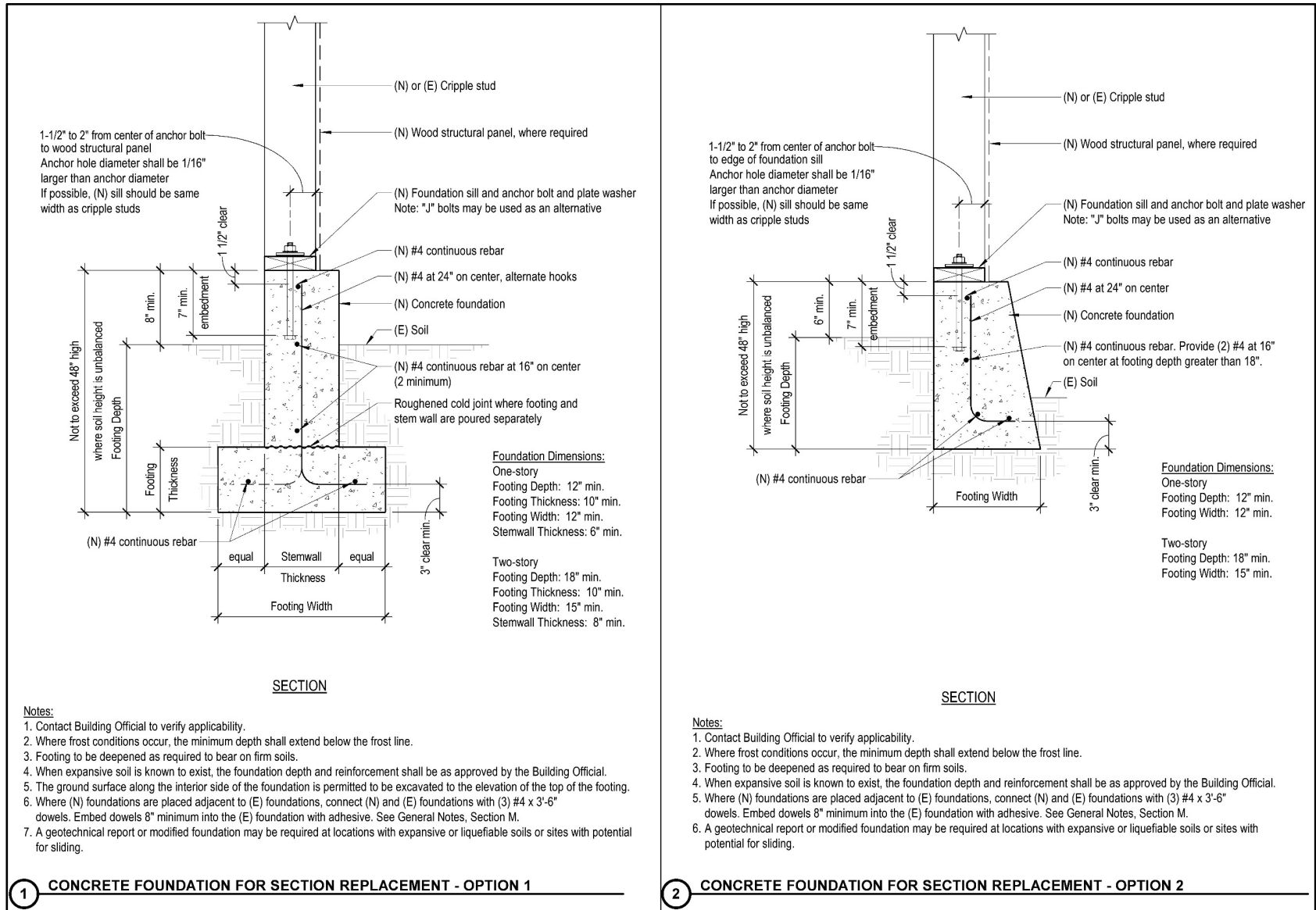


Figure 4.4-19 Foundation replacement details. Sheet D7.

Chapter 5

Vulnerability-Based Assessment and Retrofit of Living-Space-Over-Garage Dwellings

5.1 General

This chapter contains provisions for vulnerability-based assessment and retrofit of ground-story *bracing walls* in wood light-frame *living-space-over-garage dwellings*. These provisions are also permitted to be used in other conditions in which enclosed living space occurs over unoccupied ground floor areas having inadequate ground-story wall bracing except those structures that can be assessed and retrofitted as crawlspace dwellings and/or hillside dwellings defined by this standard.

The primary purpose of this chapter is the reduction of earthquake-induced damage to wood light-frame living-space-over-garage dwellings.

5.1.1 Use of this Chapter

In addition to the scope limits of Section 1.8, the dwelling shall comply with all of the eligibility criteria of Table 5.1-1. Where dwelling is not compliant with one or more of the eligibility statements, assessment and retrofit in accordance with this chapter shall not be permitted.

5.1.2 Vulnerability-Based Assessment and Retrofit Methods

Where a dwelling complies with Section 5.1.1, the dwelling need not be assessed and may be retrofitted in accordance with the prescriptive retrofit provisions of Section 5.4 or the simplified engineered retrofit provisions of Section 5.5 as applicable. If the dwelling does not comply with Section 5.1.1, assessment shall be in accordance with Section 5.3; alternately, assessment is not required if retrofit is to be provided. Where retrofit is required by Section 5.3, retrofit shall be in accordance with Section 5.1.3 or Section 5.1.4.

5.1.3 Prescriptive Retrofit

Dwellings compliant with the eligibility criteria of Table 5.1-1 and all of the additional eligibility criteria of Table 5.1-2 shall be permitted to use the prescriptive retrofit provisions of Section 5.4.

Table 5.1-1 Eligibility Criteria for Use of Chapter 5

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is a detached <i>one- or two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> and assessment and retrofit will occur for each attached townhouse unit (the full <i>townhouse structure</i>).		
2	The dwelling is of wood <i>light-frame construction</i> and has a maximum of one story above the garage story.		
3	The dwelling is a <i>living-space-over-garage</i> dwelling, as defined in Chapter 2.		
4	The dwelling perimeter (not including porches or other appurtenances) is supported on continuous concrete foundations, concrete <i>stem walls</i> or thickened slab edge footings.		
5	The lower (garage) level floor is constructed of a conventionally reinforced <u>and/or post-tensioned</u> concrete slab on ground (or at least the portion of the floor that bounds the garage).		

Table 5.1-2 Additional Eligibility Criteria for Use of Prescriptive Retrofit Provisions (Section 5.4)

Scoping Statement	Compliant	Non-Compliant
1	The dwelling is located within <i>Seismic Design Category</i> (SDC) B through E as noted in Section 1.6.	
2	The weight of roofing material shall not exceed 12 psf (measured on slope).	
3	The weight of exterior wall finish shall not exceed 10 psf, except veneer wainscots supported on concrete or masonry foundations that are permitted to extend up to four feet above the top of foundation.	
4	Weight of interior wall finish shall not exceed 8 psf, except that masonry fireplace surrounds not more than 4 inches thick and not more than 100 square feet in area are permitted to exceed this weight.	
5	Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limited to 25% of the total floor area of each level.	
6	Floors in each story are at the same level, excluding slab on ground portions.	
7	The building area (determined in Section 5.4.4) shall not exceed 2,000 square feet.	
8	No part of the foundations is constructed of unreinforced masonry or stone.	
9	Clear floor to ceiling heights at any occupied level do not exceed 9 feet.	
10	The aspect ratio of the full depth of the dwelling at the lowest level to width of the garage (plan length to plan width) shall not be greater than 2 ½ to 1. See commentary Section C5.4.4.	

5.1.4 Simplified Engineered Retrofit

Where the prescriptive retrofit provisions of Section 5.4 are not used, a simplified engineered retrofit shall be provided in accordance with Section

5.5, or a general engineered retrofit shall be provided in accordance with Section 1.7.2.

5.2 Definitions and Minimum Requirements

The definitions of Chapter 2 are applicable to all assessments and all retrofits designed in accordance with Chapter 5. The minimum requirements of Chapter 3 are applicable to all retrofits designed in accordance with Chapter 5. See Figure 5.4-30 for minimum requirements at existing single and double top plate splices, cutouts at braced wall panels, and allowable notching and reinforcing for cripple wall top plates and studs.

5.3 Vulnerability-Based Assessment

5.3.1 Scope

The assessment criteria of this section shall be used to determine whether existing ground-story *bracing walls*, foundations, anchorage, and connections are in compliance with the requirements of this chapter. Where they are in compliance with the requirements of this chapter, retrofit is not required. Where they are found to not be in compliance with the requirements of this chapter, retrofit in accordance with Section 5.4, Section 5.5 or a general engineered retrofit is required. The simplified assessment provisions of Section 5.3.2 shall be permitted to be used where applicable. Where Section 5.3.2 requires a detailed assessment, this shall be provided in accordance with Section 5.3.3.

In lieu of a detailed assessment, the dwelling may be retrofit in accordance with Section 5.4 or 5.5 as applicable.

5.3.2 Simplified Assessment

Ground-story bracing walls in living-space-over-garage dwellings shall be assessed in accordance with Table 5.3-1.

Where existing ground floor bracing is deemed to conform to the assessment statement, this bracing as well as the elements they are directly attached to, shall also be assessed to identify incomplete or inadequate installation, damage, and deterioration that might significantly affect seismic performance. This condition assessment can be limited to those elements that are visible or easily accessed. Where this assessment identifies incomplete or inadequate installation, damage or deterioration, the elements shall be deemed not adequate for use. For these conditions, the applicable assessment statement within Table 5.3-1 shall be determined to be false and

the indicated compliance step taken. Alternately, a detailed assessment of existing elements in accordance with Chapter 8 may be provided.

The scope of this assessment shall be permitted to be based on the judgment of the evaluator. The findings and documentation of this investigation shall be subject to the approval of the *building official* where required.

Table 5.3-1 Simplified Structural Assessment for Living-Space-Over-Garage Dwellings

Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance Step if Unknown
Bracing walls throughout the ground-story comply with one or more of the following: <ul style="list-style-type: none"> • Conventional construction bracing requirements from 1994 or 1997 Uniform Building Code • Engineered seismic design provisions of the 1997 Uniform Building Code • Seismic bracing provisions of 2000 International Residential Code or later • Engineered seismic design provisions of 2000 International Building Code or later 	Retrofit of ground-story bracing walls is not required	Retrofit of ground-story bracing walls is required	Provide detailed assessment in accordance with Section 5.3.3

5.3.3 Detailed Assessment

Detailed assessment for type, extent, and condition of ground-story *bracing walls* shall be assessed in accordance with Section 8.5.

5.3.4 Engineered Assessment

As an alternate to the detailed assessment requirements of Section 5.3.3 and Section 8.5, an evaluation by a *registered design professional* can be provided to demonstrate that existing components are in compliance with this standard. This evaluation shall utilize all engineering criteria listed in Section 5.5. For guidance, assumptions made in developing the simplified engineered vulnerability-based retrofit in Section 5.5 are listed in the commentary for Section 5.5.

5.4 Prescriptive Vulnerability-Based Retrofit

5.4.1 Scope

Living-space-over-garage dwellings and dwelling units complying with all eligibility criteria of Table 5.1-1 and Table 5.1-2 are permitted to use the prescriptive retrofit provisions of this section. Other dwellings shall have an engineered retrofit designed in accordance with Section 5.5.

Where the retrofit of the ground-story wall bracing is required by Section 5.3, living-space-over-garage dwellings shall be retrofit in accordance with all requirements of Section 5.4.

Where a dwelling's actual conditions require modification of the vulnerability-based retrofit solutions identified within this section, additional or modified details may be generated by a *registered design professional* and used to supplement the prescriptive procedures of this section. These supplemental details shall bear the stamp and seal of the *registered design professional* in accordance with the statutes of the jurisdiction in which the retrofit is to be performed and *approved* by the *building official*.

All figures referenced in Section 5.4 describing the prescriptive retrofit provisions can be found at the end of Chapter 5.

5.4.2 Determination of Earthquake Retrofit Schedule

The prescriptive vulnerability-based retrofit procedures of Section 5.4 have been developed for short-period response acceleration parameter S_{DS} values of 1.0, 1.2, and 1.5. The S_{DS} value required for retrofit design shall be determined in accordance with Section 1.6. Based on the determined S_{DS} value, the applicable figure presenting the relevant Earthquake Retrofit Schedule shall be selected from Figure 5.4-1.

5.4.3 Determination of Weight Classification

The prescriptive vulnerability-based retrofit procedures of Section 5.4 have been developed for dwellings using three *weight classifications*: heavy, medium, and light construction. Further, eight weight combinations, based upon the type of exterior and interior wall finishes and roofing materials, are assigned to three weight classifications as identified within Figure 5.4-2. Where interior or exterior finishes vary, a heavier type finish shall be assumed where 25% or more of that finish type exists within the dwelling.

5.4.4 Determination of Building Area

The building area that is used to define the vulnerability-based retrofit is equal to the width of the garage times the full depth of the house at the ground level floor (in square feet) for all living-space-over-garage dwellings. See Section C5.4.4 for clarification of area calculations.

5.4.5 Determination of Building Retrofit Type

The building retrofit type is based on the existing configuration of the living-space-over-garage dwelling. Where the existing dwelling does not have a *ground-story residential unit*, the retrofit shall include *retrofit elements* at the

dwelling front, back, and side walls, as shown in the Earthquake Retrofit Schedules of Figures 5.4-7 through 5.4-24 as applicable. Retrofit elements at the front and back walls are permitted to be of any of the retrofit element types in Section 5.4.6 through Section 5.4.8. Retrofit elements at the side walls are to be wood structural panel shear walls in accordance with Section 5.4.6.

Where the existing dwelling has a ground-story residential unit, the retrofit shall include retrofit elements at the garage front and side walls, and the wall separating the garage use from the residential use. Retrofit elements at the front wall are permitted to be of any of the retrofit element types in Section 5.4.6 through Section 5.4.8 and shall include retrofit elements as shown in the Earthquake Retrofit Schedules of Figures 5.4-7 through 5.4-24 as applicable. Retrofit elements at the side walls and wall separating the garage use from the residential-use are to be *wood structural panel* shear walls in accordance with Section 5.4.6.

5.4.6 Wood Structural Panel Shear Wall Retrofit

Where retrofits are identified by Section 5.4.5 to require wood structural panel shear walls, retrofit shall conform to this section.

5.4.6.1 Wood Structural Panel Shear Wall Sheathing

Wood structural panel shear walls, with or without *tie-downs* shall meet the minimum total length requirements of the Earthquake Retrofit Schedules in Figures 5.4-7 through 5.4-24 as applicable (exclusive of the Alternate Earthquake Retrofit Schedules of Figures 5.4-9, 5.4-12, 5.4-15, 5.4-18, 5.4-21, and 5.4-24).

Wood structural panel installation shall be in accordance with Figure 5.4-28 and additional requirements per Section 3.3.5.

5.4.6.2 Foundation for Wood Structural Shear Panel

Where new foundations are required by Section 5.4.6, a new foundation shall be provided, extending across the full width of the area being retrofitted to existing perpendicular foundations. The new foundation and connection of the new foundation to the perpendicular foundation shall be in accordance with Figure 5.4-26.

5.4.6.3 Tie-Downs to Existing Foundations

Where tie-downs to existing foundations are required by Section 5.4.6, tie-downs shall be one of the types listed in Figure 5.4-5 and shall be installed in accordance with Figure 5.4-29. In addition, the foundation requirements of

Section 5.4.6.4 shall be met. Where these requirements are not met, a new foundation system shall be provided in accordance with Section 4.4.4 or an engineered retrofit design shall be provided in accordance with Section 5.5.

Where tie-downs to new foundations are required by Section 5.4.5, tie-downs shall be one of the types listed in Figure 5.4-5 and shall be installed in accordance with Figure 5.4-26.

5.4.6.4 Existing Foundation Visual Verification and Testing Requirements

Where tie-downs to existing foundations are used in accordance with the Earthquake Retrofit Schedules in Figures 5.4-7 through 5.4-24 as applicable (exclusive of the Alternate Earthquake Retrofit Schedules of Figures 5.4-9, 5.4-12, 5.4-15, 5.4-18, 5.4-21, and 5.4-24), additional visual verification and testing of the existing foundation system is required to be completed by the owner or general contractor and *approved* by the *building official*.

5.4.6.4.1 Visual Verification

The size of existing foundation systems at the location of new tie-down anchors shall be verified to be at least 15 inches deep (“D”) and 8 inches wide (“W”). The dimension “D” shall be measured from the bottom of footing to the underside of the existing mudsill. The dimension “W” shall be measured from the top outside face of footing to the inside top face of footing.

5.4.6.4.2 Existing Foundation Quality Requirements

Verification of the overall quality of the concrete along any wall line requiring tie-downs shall be made by use of a minimum of two sacrificial torque tests along each wall line where tie-downs are used. These tests shall consist of installing 1/2- or 5/8-inch threaded concrete anchors into the existing concrete and verifying that a value per Table 5.4-1 can be achieved. Torque tests can be performed either by 1) the owner; 2) a general contractor; 3) or a special inspection company or testing agency hired by the owner and as *approved* by the *building official*.

Table 5.4-1 Foundation Verification Requirements

Diameter	Screw Anchor Torque (ft-lbs.)	Adhesive Anchor Torque (ft-lbs.)
1/2”	35	15
5/8”	50	20

5.4.6.4.3 Existing Foundation Tension Test Requirements

Where tie-downs to an existing foundation are identified in Section 5.4.6, each adhesive anchor shall be torque tested in accordance with Table 5.4-1. Torques in excess of those shown for adhesive anchors shall not be applied. Tests shall not be performed prior to adequate curing per manufacturer's requirements. Anchors where torque tests fail shall be replaced and re-installed. Where torque tests continue to fail, the existing foundation system shall be replaced locally for a minimum of 30 inches on each side of the proposed tie-down anchor location. New foundation segments shall be dowelled into the existing foundation to provide continuity.

5.4.6.4.4 Adhesive Anchor Installation Verification

Where "With Tie-downs" is specified within the Earthquake Retrofit Schedules in Figures 5.4-7 through 5.4-24, installation shall conform to the manufacturer's installation instructions. Items 1 through 10 below shall be verified by performed and verified by the general contractor, ~~or~~ owner, or shall be permitted to be verified by a special inspection company or testing agency hired by the owner and *approved by the building official.*

1. Drill all holes to the specified diameter and depth.
2. Blow all holes clean of dust with oil-free compressed air for a minimum of 4 seconds.
3. Clean all holes with a nylon or steel brush for a minimum of 4 cycles (per manufacturer's instructions).
4. Blow holes clean of dust with oil-free compressed air for a minimum of 4 seconds.
5. Check adhesive cartridge expiration date and required minimum temperature for adhesive cure.
6. Open cartridge, connect the required nozzle, and install the cartridge in the dispensing tool.
7. Purge out the required amount of adhesive to assure proper mixing per the manufacturer's instructions prior to filling any holes with adhesive.
8. Fill the holes 1/2 to 2/3 full, starting at the bottom of the hole to prevent air pockets and withdraw the nozzle as the hole fills up.
9. Insert a clean and oil-free anchor turning slowly until the anchor contacts the bottom of the hole.

10. Do not disturb the anchor until adhesive has fully cured. See manufacturer's instructions for cure time required.

Certification of installation and inspection shall be provided to *building official* when performed and verified by the general contractor, owner or when verified by a special inspection or testing agency prior to inspection by the jurisdiction and installation of sheathing.

5.4.6.5 Foundation Sill Plate Anchorage to the Foundation

Foundation sill plate anchorage shall be retrofit in accordance with this section. Foundation sill plate anchorage of one of the types listed in Figure 5.4-3 or Figure 5.4-4 shall be provided in accordance with Figure 5.4-25. The number of anchors per wall section shall be in accordance with the Earthquake Retrofit Schedules in Figures 5.4-7 through 5.4-24 and shall be evenly distributed along each wall line. Proper fastener types and quantity required by the manufacturer shall be used to connect the connector to the framing.

5.4.6.6 Connection to Dwelling Above

Existing or new rim joists, blocking, and miscellaneous framing members shall be connected to the dwelling above in accordance with Figure 5.4-27, and with the quantity and type of connectors specified in the Earthquake Retrofit Schedules in Figures 5.4-7, 5.4-8, 5.4-13, 5.4-14, 5.4-19, or 5.4-20.

5.4.7 Steel Retrofit Column

Retrofits using steel columns shall be in accordance with this section.

5.4.7.1 Steel Column

Steel column sections shall comply with ASTM A572 Grade 50 or A992. Identification of structural steel shall comply with AISC 360. One steel retrofit column shall be selected in accordance with Figure 5.4-9, 5.4-12, 5.4-15, 5.4-18, 5.4-21, or 5.4-24 for each wall line to be braced per this section. Installation and detailing of the steel column shall be in accordance with Figure 5.4-31.

5.4.7.2 Foundation for Steel Column

A new retrofit foundation shall be provided, extending across the full width of the area being retrofitted to existing perpendicular foundations. The new foundation shall be in accordance with Figure 5.4-32. Connection of the new foundation to the perpendicular foundation shall be in accordance with Figure 5.4-26. The new foundation shall be cast-in-place around the steel column.

5.4.7.3 Collector for Steel Column

A new collector shall be provided, extending the full width of the area of retrofit. The new collector shall be in accordance with Figure 5.4-31.

5.4.8 Alternate Lateral Force Resisting Systems Retrofit

Retrofits that *Alternate Lateral Force Resisting Systems* shall be in accordance with this section.

5.4.8.1 Alternate Lateral Force Resisting Systems

Alternate Lateral Force Resisting Systems that are prefabricated wood shear panels, prefabricated cold-formed steel shear panels, or equivalent systems complying with the requirements of ICC-ES AC 436 or FEMA P-795, or have been tested in accordance with ASTM D7989 in a manner and with documentation acceptable to the *building official*. *Alternate lateral force resisting systems* shall be installed in accordance with the manufacturer's installation instructions and Section 5.4.8. *Alternate lateral force resisting systems* shall be selected in accordance with the Earthquake Retrofit Schedules in Figure 5.4-9, 5.4-12, 5.4-15, 5.4-18, 5.4-21, or 5.4-24 for each wall line to be braced per this section. Placement and detailing of the *proprietary shear wall* shall be as permitted by Figure 5.4-33.

5.4.8.2 Foundation for Alternate Lateral Force Resisting Systems

A new retrofit foundation shall be provided, extending across the full width of the area being retrofitted to existing perpendicular foundations. The new foundation and connection of the new foundation to the perpendicular foundation shall be in accordance with Figure 5.4-32 [for proprietary steel column systems](#) and Figure 5.4-34 [for proprietary shear wall systems](#).

5.4.8.3 Collector for Proprietary Shear Wall

A new collector shall be provided, extending the full width of the area of retrofit. The new collector shall be in accordance with Figure 5.4-31-for proprietary steel column systems and Figure 5.4-33 for proprietary shear wall systems.

5.5 Simplified Engineered Vulnerability-Based Retrofit

5.5.1 General

Engineered retrofit of *living-space-over-garage ground-story bracing walls* shall be in accordance with ASCE/SEI 7 Section 12.14, Simplified Alternative Structural Design Criteria for Simple Bearing Wall or Building Frame Systems, as amended below. Material design capacities for all components shall be as specified by the adopted building code.

1. The scope of seismic evaluation and retrofit, where required, shall include ground-story vertical elements, such as steel columns, proprietary shear walls, or wood structural panel shear walls, the foundation, anchorage to the foundation, collectors at the top of the vertical element, and anchorage to floor framing above.
2. Seismic weight for purposes of calculating base shear shall include the dead load summed over all stories and occurring in an area defined by the garage width times the length of the dwelling perpendicular to the garage.
3. ASCE/SEI 7 Section 12.14 shall be modified as shown in Table 5.5-1. ASCE/SEI 7 section shall either be applicable as written (Y) with or without notes; not applicable (N); or applicable with clarifications noted (M).

Table 5.5-1 ASCE/SEI 7 Section 12.14 Application Matrix

ASCE/SEI 7 Section	Applicability	Notes
12.14.1.1	N	All limitation listed within Items 1 through 12 shall be assumed to comply and ASCE/SEI 7 Section 12.14 is eligible for use
12.14.1.2	Y	
12.14.1.3	M	See Chapter 3 for additional definitions
12.14.1.4	M	Notations as applicable
12.14.2	M	See Section 5.5.1 Item 1
12.14.3	M	See Section 5.5.1 Item 2
12.14.3.1	Y	
12.14.3.2	M	E_{mh} shall be taken as $1.5Q_E$
12.14.4.1	N	
12.14.4.2	N	
12.14.5	M	See Section 5.5.2 Item 1
12.14.6	Y	
12.14.7	N	
12.14.8.1	M	$F = 1.0$ for two-story dwellings
12.14.8.2	Y	
12.14.8.3	Y	
12.14.8.3.1	M	See Section 5.5.2 Items 1 and 2
12.14.8.3.2	N	
12.14.8.3.2.1	N	
12.14.8.4	N	
12.14.8.5	N	

4. Wood structural panel shear walls, steel columns, *alternate lateral force resisting systems*, and their seismic load path shall be designed using a seismic response modification factor, R , of 5.0.
5. Finish and bracing materials other than wood structural panels (per definitions in Chapter 2) shall not be considered to provide seismic capacity.
6. The in-plane *load path connections* for anchorage to foundations and anchorage to floor framing above shall be provided at all locations where wood structural panel for retrofit shear walls are provided. In-plane load path connections shall be designed using load combinations with an overstrength factor, Ω_0 , of 1.5 in lieu of 2.5 specified in ASCE/SEI 7 Section 12.14.3.2.2.
7. Where tie-downs are used in existing foundations, the registered design professional *registered design professional* shall be responsible for evaluating the existing foundation system.
8. Where tie-downs are used in new foundations, anchorage of shear walls for overturning shall be in accordance with the concrete design provisions of the adopted building code.

5.5.2 *Additional Simplifying Assumptions*

The following simplifications shall be permitted to be made in the engineered retrofit design:

1. Where the existing dwelling does not have a ground-story residential unit, the retrofit shall include retrofit elements at the dwelling front, back and side walls, and each wall shall resist 50% of the total base shear.
2. Where the existing dwelling has a ground-story residential unit, the retrofit shall include retrofit elements at the garage front and side walls, and the wall separating the garage use from the residential use. The front wall shall be designed to resist 25% of the total base shear; the back wall of the garage and each side wall shall be designed to resist 50% of the base shear.
3. Retrofit elements at the front/back walls shall be offset a maximum of 4 feet from the exterior wall line.
4. When designing vertical lateral load-resisting elements for overturning (wood structural panel shear walls, steel columns, or proprietary shear walls), in lieu of a more detailed overturning analysis of the entire dwelling, each exterior wall line shall be designed to resist its local overturning moment plus 15 percent of the total overturning moment of

the superstructure. The calculations of forces F_R and F_{2nd} (where applicable) can be based upon tributary mass to those levels per ASCE/SEI 7 Section 12.14-13.

5. The allowable tension load at the end of a wood structural panel shear wall can be assumed as follows:
 - a. Where two *post-installed anchor* bolts are installed at each end of wood structural panel shear wall as indicated Figure 5.4-28, the wall may assume to have an allowable uplift capacity of 1.5 kips (ASD), provided there is a minimum length to height ratio of 2.0 for the sheathed portion of the *cripple wall*.
 - b. Where one *post-installed anchor* bolt and one tie-down anchor are installed at each end of a section of wood structural panel shear wall as indicated in Figure 5.4-29, the end of wall may be assumed to have an allowable uplift capacity of 3.0 kips (ASD).
6. Soil *Site class* may be assumed to be Type C if specific site class information is not available.

5.5.3 Design of Steel Column Retrofit

Steel retrofit columns shall be designed in accordance with the seismic forces of Section 5.5 and the material design provisions of the adopted building code. For purposes of seismic design per AISC 341, steel columns shall be treated as special steel cantilevered columns.

Exceptions

1. Steel column and load path design shall use the seismic response modification factor, R , specified in Section 5.5.1.
2. Steel columns shall be designed to have a full moment connection to the grade beam foundations. Columns shall be designed to have a pinned connection at the top of the column.
3. Steel retrofit columns shall be selected such that the demand to capacity ratio for column flexural strength does not exceed 1.2.
4. The grade beam minimum dimensions shall not be less than two-foot wide by two-foot deep. The grade beam shall be doweled into the existing foundation at each end and shall be designed per ASCE/SEI 7 and the foundation and concrete requirements of the applicable building code.
5. The steel column is exempt from meeting the drift and deformation requirements of ASCE/SEI 7 Section 12.12.

5.5.4 Design of *Proprietary Shear Wall Retrofit*

Proprietary walls shall be designed in accordance with the provisions of Section 5.4.8.1, the seismic forces of Section 5.5, and the material design provisions of the adopted building code.

1. *Proprietary shear walls* and load path design shall use the seismic response modification factor, R , specified in Section 5.5.1.
2. *Proprietary shear walls* shall be selected such that the demand to capacity ratio for wall shear strength does not exceed 1.0.
3. *Proprietary shear wall* is required to meet the drift and deformation requirements of ASCE/SEI 7 Section 12.12, and any additional requirements specified by the manufacturer or as a condition of acceptance by the *building official*.
4. The grade beam dimensions shall not be less than two foot wide by two foot deep. The grade beam shall be doveled into the existing foundation at each end and shall be designed per ASCE/SEI 7 and the foundation and concrete requirements of the adopted building code.

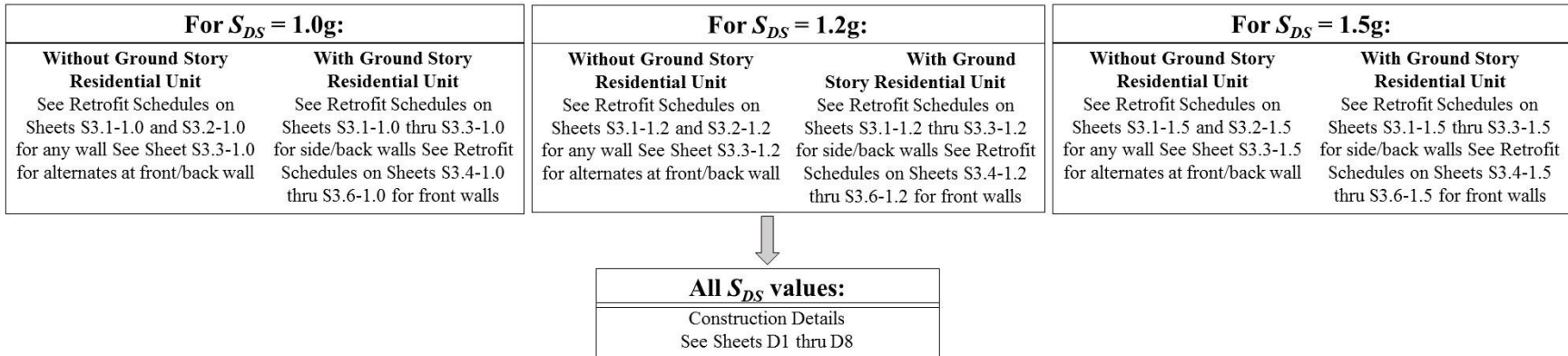


Figure 5.4-1 Flowchart for selecting Earthquake Retrofit Schedule.

Vulnerability-Based Assessment and Retrofit of Hillside Dwellings

6.1 General

This chapter contains provisions for vulnerability-based assessment and retrofit of *base-level diaphragm* anchorage and *crawlspace walls* in wood light-frame *hillside dwellings* (Figure 6.1-1).

Vulnerabilities addressed by this chapter are shown in Figure 6.1-2 and include:

- Anchorage of the base-level diaphragm to the *uphill foundation*
- Wood light-frame crawlspace walls between the base-level diaphragm and the foundation

The primary purpose of this chapter is the reduction of earthquake-induced damage to wood light-frame hillside dwellings. Not addressed by this chapter are potential site soil hazards. See Section 1.9 and non-mandatory Appendix S for further information.

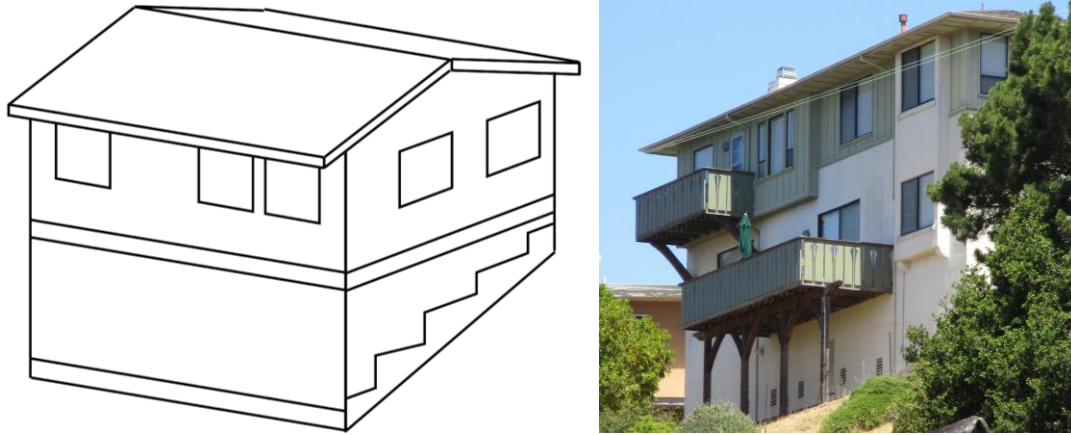


Figure 6.1-1 Hillside dwelling schematic isometric and photo.

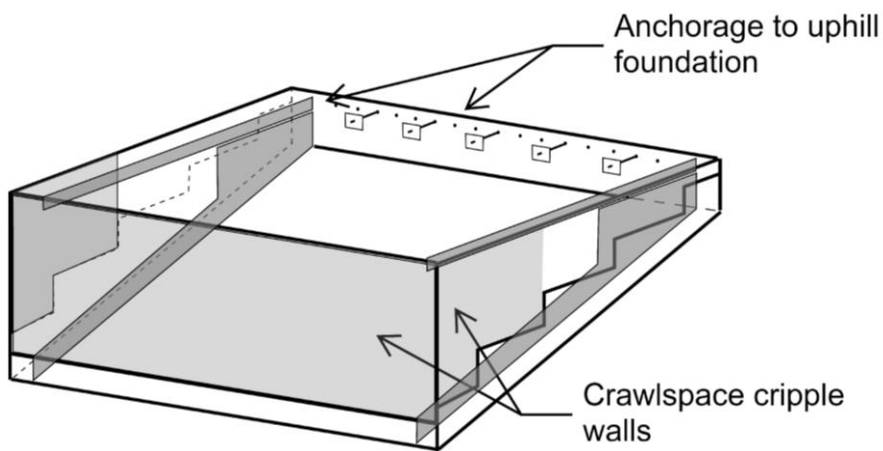


Figure 6.1-2 Hillside dwelling schematic isometric of dwelling crawlspace including anchorage to uphill foundation and crawlspace walls.

6.1.1 Use of this Chapter

In addition to the scope limits of Section 1.8, the dwelling shall comply with all of the eligibility criteria of Table 6.1-1. Where the dwelling is non-compliant with one or more of the eligibility criteria, assessment and retrofit in accordance with this chapter is not permitted.

6.1.2 Vulnerability-Based Assessment and Retrofit Methods

Assessment of dwellings shall be in accordance with Section 6.3. Where retrofit is required by Section 6.3, retrofit shall be in accordance with the simplified engineered vulnerability-based retrofit provisions of Section 6.5 or the general engineering retrofit provisions of Section 1.7. Prescriptive vulnerability-based retrofit provisions are not provided for hillside dwellings.

6.2 Definitions and Minimum Requirements

The definitions of Chapter 2 are applicable to all assessments and all retrofits designed in accordance with Chapter 6. The minimum requirements of Chapter 3 are applicable to all retrofits designed in accordance with Chapter 6.

Table 6.1-1 Eligibility Criteria for Use of Chapter 6

1	The dwelling is a hillside dwelling, as defined in Chapter 2.		
2	The dwelling is a detached <i>one-</i> or <i>two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> and assessment and retrofit will occur for each attached townhouse unit (the full <i>townhouse structure</i>).		

Table 6.1-1 Eligibility Criteria for Use of Chapter 6 (continued)

3	The dwelling is two stories or less above the base-level diaphragm.		
4	The dwelling is of wood <i>light-frame construction</i> .		
5	Existing perimeter walls below the base-level diaphragm are of wood light-frame construction, or a combination of wood light-frame and concrete construction.		
6	Existing perimeter walls below the base-level diaphragm are supported on a continuous concrete foundation or will be retrofit to be supported on a continuous foundation. Continuous foundation includes continuous perimeter spread footing with stem wall, or continuous grade beams or tie-beams supported on pier or caisson foundations with or without continuous concrete piers.		
7	The clear height of the tallest crawlspace stud wall does not exceed 16 feet.		
8	The site slope as measured along the sides of the dwelling, starting from the highest uphill point to the lowest downhill point exceeds 1 to 5 (vertical to horizontal).		
9	The <i>base-level diaphragm</i> is of wood light-frame construction and is entirely in one plane without vertical offsets, such as a step in the floor or <i>split level</i> .		
10	The garage is detached from the dwelling.		
11	The exterior framed walls immediately above the uphill foundation sit directly above the uphill foundation for not less than 75% of the uphill foundation length.		
12	No masonry <i>chimney</i> is attached to the side of the dwelling, extends through the dwelling, or sits on any floor level of the dwelling.		

6.3 Vulnerability-Based Assessment

6.3.1 Scope

The assessment criteria of this section shall be used to determine whether existing diaphragm anchorage to the uphill foundation and existing framed *crawlspace walls* and their *load path connections* are in conformance with the requirements of this chapter. Where they are in compliance with the requirements of this chapter, retrofit is not required. Where they are found to not be in compliance with the requirements of this chapter, retrofit is required.

Assessment shall be in accordance with the detailed vulnerability-based assessment provisions of Section 6.3.2 and the engineered vulnerability-based assessment provisions of Section 6.3.3, or the general engineering assessment provisions of Section 1.7. Assessment using a simplified

vulnerability-based assessment approach is not provided for hillside dwellings.

In lieu of assessment, the dwelling may be retrofit in accordance with the requirements of this chapter.

6.3.2 Detailed Assessment

This section provides detailed vulnerability-based assessment criteria for foundations and crawlspace walls in hillside dwellings. Anchorage to the uphill foundation is required to be assessed in accordance with the engineered vulnerability-based assessment method of Section 6.3.3.

Hillside dwelling crawlspace walls below the base-level diaphragm and their load path connections, shall be assessed in accordance with all of the following:

- Foundations shall be assessed in accordance with foundation detailed assessment methods of Section 8.1.
- Anchorage of framed crawlspace walls to the foundation shall be assessed in accordance with *foundation sill plate* anchorage to foundation detailed assessment method of Section 8.2.
- Crawlspace wall sheathing shall be assessed in accordance with *bracing wall* sheathing detailed assessment method of Section 8.3.

Retrofit shall be provided as required to address deficiencies identified by this section.

6.3.3 Engineered Assessment

Existing base-level diaphragm anchorage to the uphill foundation shall be assessed in accordance with this section. An evaluation by a *registered design professional* shall demonstrate that existing anchorage is in compliance with this standard, using the simplified engineered vulnerability-based retrofit design criteria of Section 6.5. Where the anchorage is found to be compliant with the provisions of Section 6.5, it shall be deemed in compliance with this chapter. Where the anchorage is not compliant, the anchorage shall be retrofit.

As an alternative to the detailed vulnerability-based assessment provisions of Section 6.3.2, the foundation and crawlspace walls and their load-path connections shall be permitted to be assessed in accordance with this section. An evaluation by a registered design professional shall demonstrate that

existing diaphragm and framed crawlspace walls, including their anchorage to the foundation and to floor framing above, are in compliance with this standard, using the simplified engineered vulnerability-based retrofit design criteria of Section 6.5. Where the crawlspace walls and load path connections are found to be compliant with the provisions of Section 6.5, it shall be deemed in compliance with this chapter. Where they are not compliant, the anchorage shall be retrofit.

6.4 Prescriptive Vulnerability-Based Retrofit

Use of a prescriptive vulnerability-based retrofit is not provided for hillside dwellings.

6.5 Simplified Engineered Vulnerability-Based Retrofit

6.5.1 Scope

This section provides simplified engineered vulnerability-based retrofit provisions for foundations, base-level diaphragm anchorage to the uphill foundation, and the framed crawlspace walls and their load path connections.

Dwellings identified by Section 6.3 to require foundation retrofit shall comply with Sections 6.5.2 and 6.5.3.

Dwellings identified by Section 6.3 to require retrofit of anchorage to the base-level diaphragm shall comply with Sections 6.5.2 and 6.5.4.

Dwellings identified by Section 6.3 to require retrofit of crawlspace wall bracing, crawlspace wall anchorage to the foundation, or crawlspace wall connection to the floor framing above shall comply with Sections 6.5.2 and 6.5.5.

6.5.2 General

Retrofit of hillside dwellings shall use seismic design forces as follows:

1. In accordance with Section 6.5 and, where specified, by ASCE/SEI 7, or the adopted building code.
2. The material design provisions of the adopted building code shall be used, except as modified by Section 6.5.

6.5.2.1 Seismic Base Shear for Foundation Retrofit

Where construction of a new foundation or retrofit of an existing foundation is required, the foundation design shall be in accordance with the following:

1. Loads and load combinations shall be in accordance with the adopted building code. The seismic response modification factor, R , shall be taken as 4.0. The foundation shall be designed for the effects of *primary anchor* forces and shear anchor forces as per Section 6.5.4, except that the R -factor for primary and shear anchor forces is permitted to be taken as 4.0 for design of the foundation and transmission of forces to supporting soils. The foundation need not be designed for the effects of *secondary anchor* forces.
2. Primary, secondary, and shear anchors and their anchorage to the foundation shall be in conformance with the requirements of Section 6.5.4.

6.5.2.2 Seismic Base Shear for Other Retrofits

The design seismic base shear for retrofit of base-level diaphragm anchorage to the uphill foundation and retrofit of crawlspace walls and their load path connections shall be determined in accordance with Equation 6.5-1, and shall be assumed to act on the system providing seismic bracing to the base-level diaphragm:

$$V = S_{DS}W / R \quad (6.5-1)$$

where:

S_{DS} = The short period design spectral response acceleration parameter determined in accordance with ASCE/SEI 7 Chapter 11

W = The effective seismic weight of the structure as defined in ASCE/SEI 7. The seismic weight shall include all dwelling weight from the base-level diaphragm and above, plus half of the weight of walls from the underside of the base-level diaphragm to the top of the foundations

R = The seismic response modification factor, as defined in Sections 6.5.4 through 6.5.5

Where seismic loads are acting in combination with other load types, the loads and load combinations shall be in accordance with the adopted building code. Use of seismic load combinations that include overstrength are not required when using the seismic design forces of this section. Overstrength factors required for design of anchorage to concrete shall be used.

6.5.3 Retrofit of Foundations

New foundations or retrofits of existing foundations shall be designed in accordance with the loads and forces specified in Section 6.5.2.1, the

seismic design provisions of ASCE/SEI 7, and the material design provisions of the adopted building code.

6.5.4 Retrofit of Base-Level Diaphragm Anchorage

The scope of retrofit for anchorage of the base-level diaphragm to the uphill foundation shall include primary anchors, secondary anchors, and shear anchors, as identified in Figure 6.5-1.

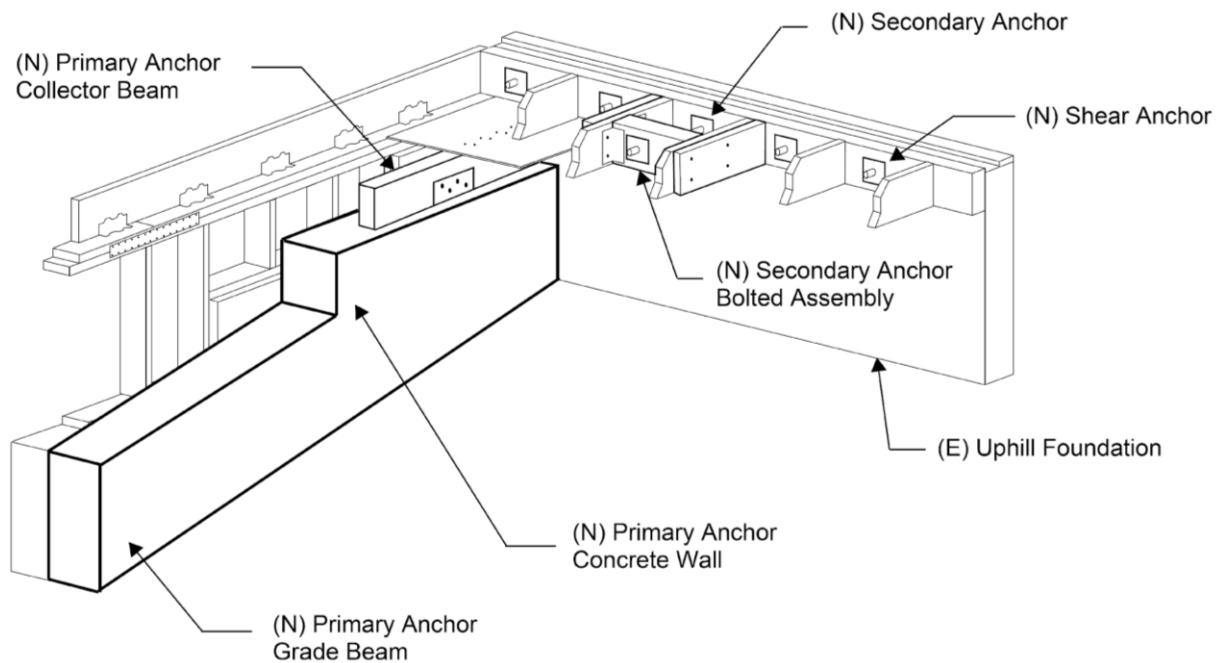


Figure 6.5-1 Interior uphill foundation corner isometric.

6.5.4.1 Design of Primary Anchors

Primary anchors shall be provided between the base-level diaphragm and the uphill foundation at each end of the dwelling uphill foundation. Additional primary anchors shall be provided at any location where a horizontal offset of four feet or more occurs in the uphill foundation between the foundation ends. Primary anchors, at locations referenced above, shall be located in line with existing walls in the story above, or as close thereto as possible.

The base shear, V , for design of primary anchors shall be determined in accordance with Equation 6.5-1, using a response modification factor, R , of 2.0. The primary anchors shall be designed to resist the entire base shear, V , for the most critical of the following three load conditions. Design of the primary anchors shall neglect the resistance provided by secondary anchors, crawlspace walls, and other existing lateral force resisting elements.

1. For *out-of-hill loading*, where two primary anchors are provided, each primary anchor at the ends of the uphill foundation shall be designed for a seismic force of $V/2$. Where primary anchors are provided between the ends of the uphill foundation, each primary anchor shall be designed for a portion of V in accordance with the base-level diaphragm area tributary to the anchor
2. For *cross-slope loading*, the seismic base shear, V , shall be applied at the dwelling center of mass, with the base-level diaphragm treated as cantilevered from, and laterally supported only by, the uphill foundation. Each primary anchor, and its associated collector, shall be designed for the cantilever diaphragm chord force calculated at each end of the diaphragm as a result of the diaphragm cantilever.
3. In no case shall a primary anchor be designed to resist a seismic force of less than the larger of $V/4$ or 3 times the secondary anchor design force.

The primary anchor shall include a chord or collector element, extending the depth of the diaphragm at the anchor location and designed to resist applicable seismic forces.

The scope of retrofit for primary anchors shall include load path connections between the base-level diaphragm and the primary anchor chord or collector element, the design of the chord/collector element, and the anchorage of the chord/collector element to the uphill foundation.

The scope of retrofit need not include evaluation or strengthening of the base-level diaphragm, provided the primary anchor chord or collector element extends and is connected to the base-level diaphragm over the full depth of the diaphragm cantilever at the primary anchor location.

The scope of retrofit need not include evaluation or strengthening of the load path from the point of anchorage to the uphill foundation, into the supporting soils, provided that it can be demonstrated that the anchorage forces will engage the foundation system without causing a local (e.g., punching or shear) failure of the concrete foundation. Where retrofit element load paths impose overturning forces, the retrofit elements shall be capable of distributing the overturning to the existing foundation.

The scope of retrofit is permitted to include strengthening of existing foundations or new foundation elements for purposes of primary anchor load path.

Design capacities and detailing for all components shall be as specified in the adopted building code.

6.5.4.2 Design of Secondary Anchors

Secondary anchors shall be provided between the base-level diaphragm and uphill foundation, distributed along the length of the uphill foundation.

Secondary anchors shall be provided at no more than four feet on center.

The base shear, V , for design of secondary anchors shall be determined in accordance with Equation 6.5-1, using a response modification factor, R , of 1.0. The secondary anchors shall be designed to collectively resist the entire base shear, V , for the out-of-hill force direction, neglecting the resistance provided by primary anchors, crawlspace walls, and other lateral force-resisting elements. Each secondary anchor shall be designed for a portion of the base shear, V , in accordance with the base-level diaphragm area tributary to the anchor.

The secondary anchor shall include a collector element, extending the depth of the diaphragm at the anchor location and designed to resist applicable seismic forces.

The scope of retrofit for secondary anchors shall include load path connections between the base-level diaphragm and the secondary anchor collector element, the design of the collector element, and the anchorage of the collector element to the uphill foundation.

The scope of retrofit need not include evaluation or strengthening of the base-level diaphragm, provided the secondary anchor collector element extends and is connected to the base-level diaphragm over the full depth of the diaphragm at the secondary anchor location.

The scope of retrofit need not include evaluation or strengthening of the load path beyond the anchorage to the uphill foundation.

Design capacities and detailing for all secondary anchor components shall be as specified in the adopted building code. Where the secondary anchor consists of a tie rod to the uphill foundation, its diameter shall not be less than that of the shear anchor.

6.5.4.3 Design of Shear Anchors

Shear anchors shall be provided between the base-level diaphragm and uphill foundation and shall be distributed along the length of the foundation. Shear

anchorage to the foundation shall be spaced at not more than 32 inches on center.

The base shear, V , for design of shear anchors shall be determined in accordance with Equation 6.5-1, using a response modification factor, R , of 1.0. The shear anchors shall be designed to collectively resist the entire base shear, V , in the cross-slope force direction, neglecting the resistance provided by primary anchors, crawlspace walls, and other lateral resisting elements. Each shear anchor shall be designed for a portion of the base shear, V , in accordance with the base-level diaphragm area tributary to the anchor.

The scope of retrofit for shear anchors shall include load path connections between the base-level diaphragm framing and the uphill foundation.

The scope of retrofit need not include evaluation or strengthening of the base-level diaphragm in-plane shear capacity.

The scope of retrofit need not include evaluation or strengthening of the load path beyond the anchorage into the uphill foundation.

Design capacities and detailing for all components shall be as specified in the adopted building code. Where the shear anchor consists of a tie rod to the uphill foundation, its diameter shall not be less than that of the secondary anchor.

Anchors serving as secondary anchors are permitted to also serve as shear anchors provided that anchorage is designed considering both tension and shear forces occurring concurrently.

6.5.5 Retrofit of Perimeter-Framed Crawlspace Walls

The scope of seismic retrofit for crawlspace walls shall include full height concrete or masonry walls over 4'-0" tall and wood light-frame crawlspace walls. The framed crawlspace walls shall include perimeter walls at the sloping sidewalls, at the downhill wall, any interior crawlspace walls, and the crawlspace wall supported on the uphill foundation, where applicable.

Retrofit shall include the wall strength, anchorage to the foundation, and connection to floor framing above.

The base shear, V , for design of crawlspace walls and their load path connections shall be determined in accordance with Equation 6.5-1, using a response modification factor, R , of 4.0. Where a crawlspace wall occurs between the base-level diaphragm and the top of the uphill foundation, this crawlspace wall shall be designed to resist the full calculated base shear, V ,

and resulting overturning moment, neglecting resistance provided by primary anchors, secondary anchors, and other crawlspace walls. All other crawlspace walls shall be designed to resist the portion of the base shear tributary to the crawlspace wall, neglecting the resistance provided by primary anchors, secondary anchors, and other lateral resisting elements. Use of wood light frame crawlspace walls within the interior of the crawlspace resisting the portion of the base shear tributary to the crawlspace wall shall be permitted, but shall not be used to reduce the seismic loading to the crawlspace wall sitting on top of the uphill foundation. If interior concrete or masonry cross slope crawlspace walls are located downslope of the uphill foundation, their tributary area can be used to reduce the seismic loading to the uphill foundation shear anchorage, but shall not be used to reduce primary or secondary anchor seismic forces.

The scope of retrofit need not include evaluation or strengthening of the base-level diaphragm capacity.

The scope of retrofit need not include evaluation or strengthening of the load path beyond anchorage of the crawlspace wall top plates to the base-level diaphragm framing or the anchorage to the foundation, except as required for *proprietary shear walls*.

Design capacities and detailing shall be as specified in the adopted building code. All framed crawlspace walls shall be retrofit to be sheathed with wood structural panel shear walls. The deflection of the crawlspace wall line, as defined by ASCE/SEI 7 Equation 12.8-15 and using $C_d = 4$, shall not exceed an allowable wall line drift of $0.02h_{sx}$. Where sheathed wood structural panel shear walls are stepped along their line, distribution of forces shall be based upon the relative stiffness of each step, and h_{sx} shall be taken as the average at the wall heights at each end.

All crawlspace concrete or concrete masonry unit (CMU) walls taller than 4'-0" and connected directly to the base-level diaphragm floor framing shall be anchored to the existing diaphragm per ASCE/SEI 7 Section 12.14.7.5, Anchorage of Structural Walls. Where CMU or concrete *stem walls* occur in the same line as wood light-frame crawlspace walls, the wood light-frame crawlspace walls shall be designed to resist seismic forces based on tributary area, irrespective of relative stiffness.

The load path connections of crawlspace walls to the base-level diaphragm and foundation shall be designed using the seismic forces specified in this section for crawlspace walls, amplified by an overstrength factor, Ω_0 , of 1.5.

Crawlspace walls shall be designed for overturning forces using the seismic forces specified in this section for crawlspace walls.

Exception:

Overturning of perimeter crawlspace walls, other than crawlspace walls between the base-level diaphragm and uphill foundation, need not be calculated provided:

1. Not less than 80% of the stud or crawlspace wall length is sheathed full height.
2. Ventilation and access openings in otherwise sheathed walls are permitted to be neglected for purposes of determining percent sheathed, as long as the length of openings does not exceed 20% of the crawlspace wall's entire length
3. A tie-down is provided at each downhill corner and at the end of each full-height sheathed segment, with an ASD capacity not less than the larger of $(1.6 \times S_{DS})$ and 2.5 kips. Tie-down design need not include evaluation or strengthening of the load path beyond the anchorage into the foundation, except as required for proprietary shear walls.

When designing crawlspace walls for overturning, using the exception above, in lieu of a more detailed overturning analysis of the entire dwelling, each crawlspace wall line shall be permitted to be designed to resist the overturning moment generated in the crawlspace wall based on the average height of the wall or wall segment, plus 10 percent of the total overturning moment of the superstructure above, calculated in accordance with the provisions of ASCE/SEI 7 Section 12.8 or 12.14 and using $R = 4.0$.

When the crawlspace wall occurs between the base-level diaphragm and uphill foundation, the crawlspace wall line shall be designed to resist the overturning moment generated in the crawlspace wall based on the average height of the wall or wall segment, plus not less than 50 percent of the total overturning moment of the superstructure above, calculated in accordance with the provisions of ASCE/SEI 7 Section 12.8 or 12.4 and using $R = 4.0$.

First story shear walls above the base-level diaphragms and over the uphill foundations shall be retrofit with tie-downs extending down into the uphill foundations and for the smaller of the force level noted above or the overturning strength capacity of the existing first floor shear wall above. Shear walls above the base-level diaphragm, over the uphill foundation, are not required to be strengthened. Proprietary shear walls are permitted to be

used as an alternative to wood structural panel crawlspace walls provided they comply with all of the following requirements:

1. The proprietary alternative lateral resisting systems (shear walls) shall have been tested in accordance with ASTM D7989 in a manner and with documentation acceptable to the *building official*, or shall be an *approved* equal.
2. The proprietary shear walls are designed using the seismic forces specified in Section 6.5.5.
3. The design of the collector and collector connection to the base-level diaphragm, up to but not including connections provided by the manufacturer, use the seismic forces of this section amplified by an overstrength factor, Ω_0 , of 1.5.
4. The design of the foundation, up to, but not including anchorage provided by the manufacturer, use the seismic forces of this section amplified by an overstrength factor, Ω_0 , of 1.5.
5. The proprietary shear wall demand to capacity ratio for wall shear strength does not exceed 1.5.
6. If multiple proprietary walls are used in a wall line, the seismic forces shall be distributed between them in accordance with their relative stiffness.

New foundations, where provided for proprietary walls, shall conform to Section 6.5.3.

Chapter 7

Vulnerability-Based Assessment and Retrofit of Masonry Chimneys and Fireplace Surrounds

7.1 General

This chapter contains provisions for the assessment and seismic retrofit of existing brick *masonry chimneys* and *masonry fireplace surrounds* in wood light-frame dwellings. Prior to selecting a retrofit, the *building official* shall be consulted to identify local ordinances that might regulate wood burning and wood burning appliances.

The primary purpose of this chapter is the reduction of earthquake-induced falling hazards associated with masonry chimneys and masonry fireplace surrounds.

7.1.1 Use of this Chapter

In addition to the scope limits of Section 1.8, the provisions of this chapter are limited to masonry chimneys and masonry fireplace surrounds in one- and two-family, wood light-frame dwellings of three stories or less.

Considerations and methods beyond those discussed in the chapter may be appropriate for dwellings listed in, or eligible for listing in, the National Register of Historic Places, or designated as historic under state or local law.

7.1.2 Vulnerability-Based Assessment and Retrofit Methods

Assessment of masonry chimneys for compliance with this chapter shall be in accordance with Section 7.3. Where retrofit is required by Section 7.3.1, retrofit shall be in accordance with Section 7.1.3 or Section 7.1.4.

Assessment of masonry fireplace surrounds for compliance with this chapter shall be in accordance with Section 7.3. Where retrofit is required by Section 7.3, retrofit shall be in accordance with Section 7.5.

7.1.3 Prescriptive Retrofit of Masonry Chimneys

Chimneys compliant with all of the eligibility criteria of Table 7.1-1 shall be permitted to use the prescriptive retrofit provisions of Section 7.4.

Table 7.1-1 Eligibility Criteria for Use of Prescriptive Chimney Retrofit Provisions (Section 7.4)

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is a detached <i>one-</i> or <i>two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> .		
2	The dwelling is a wood light-frame dwelling that is three stories or less above grade plane.		
3	The chimney is constructed of solid brick masonry.		
4	The chimney’s largest plan dimension is not more than 40 inches.		
5	The chimney is either an <i>interior chimney</i> , or an <i>exterior chimney</i> engaging only one exterior wall (i.e. not at the dwelling corner).		

7.1.4 Engineered Retrofit of Masonry Chimneys

Where the prescriptive retrofit provisions of Section 7.1.3 are not used, an engineered retrofit shall be provided in accordance with Section 7.6.

7.2 Definitions and Minimum Requirements

The definitions of Chapter 2 are applicable to all assessments and to all retrofits designed in accordance with this chapter. The minimum requirements of Chapter 3 are applicable to all retrofits designed in accordance with this chapter.

7.3 Vulnerability-Based Assessment

7.3.1 Scope

The assessment criteria of this section shall be used to determine whether the masonry chimney and the masonry fireplace surround comply with the requirements of this chapter. Where they are in compliance with the requirements of this chapter, retrofit is not required. Where they are found to not be in compliance with the requirements of this chapter, retrofit is required.

7.3.2 Simplified Assessment of Chimneys

Chimneys shall be assessed in accordance with Item 1 or 2 of Table 7.3-1.

Existing chimney elements and members to which these elements are directly attached, shall be assessed to identify incomplete or inadequate installation, damage, and deterioration that might significantly affect seismic performance. Where this assessment identifies incomplete or inadequate installation, damage or deterioration, the elements shall be deemed not adequate for use. For these conditions, the applicable assessment statement within Table 7.3-1 shall be determined to be false and the indicated compliance step taken.

Table 7.3-1 Simplified Structural Assessment for Masonry Chimneys

Item	Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance step if Unknown
1	Interior brick masonry chimneys of single-story dwellings that extend no more than twice the least plan dimension of the chimney above the roof, have no portion more than 6 feet tall that is not enclosed by full-height, finished walls on at least three faces, and whose greatest plan dimension does not exceed 40 inches.	Retrofit of chimney is not required.	Provide detailed assessment or retrofit of chimney.	Provide detailed assessment or retrofit of chimney.
2	Chimneys constructed on or after January 1, 1995.	Retrofit of chimney is not required.	Provide detailed assessment or retrofit of chimney.	Provide detailed assessment or retrofit of chimney.

7.3.3 Detailed Assessment of Chimneys

Chimneys constructed prior to 1995 shall be deemed to comply with the requirements of this chapter without retrofit if a licensed contractor or *registered design professional* verifies that all the following conditions are met:

1. Mortar is Portland cement based, fully intact, and exhibits no more than minor cracking.
2. Masonry units are fully intact and exhibit no more than minor cracking.
3. Reinforcing consists of at least four 1/2-inch diameter continuous vertical bars set in fully grouted interior spaces between wythes of *solid masonry* and/or *flue* liner. Vertical reinforcing is tied at spacing not greater than 24 inches with 1/4-inch diameter ties.
4. The chimney is attached to the structural framing at all floor and roof diaphragms more than 6 feet above grade with a minimum of two anchor straps. Each *anchor strap* is of steel with a minimum cross section area of 0.1875 square inches and secured to the chimney reinforcement. Each anchor is fastened to the structural framing with at least six 16d common nails, and framing members are properly detailed to support the strap loads.
5. The chimney does not extend vertically more than 6 feet above the lowest adjacent roof surface and whose greatest plan dimension does not exceed 40 inches.

7.3.4 Simplified Assessment of Masonry Fireplace Surrounds

Masonry fireplace surrounds shall be assessed in accordance with Item 1 or 2 of Table 7.3-2.

Existing fireplace surround elements and members to which these elements are directly attached shall be assessed to identify incomplete or inadequate installation, damage, and deterioration that might significantly affect seismic performance. Where this assessment identifies incomplete or inadequate installation, damage, or deterioration, the elements shall be deemed not adequate for use. For these conditions, the applicable assessment statement within Table 7.3-2 shall be determined to be false and the indicated compliance step taken.

Table 7.3-2 Simplified Structural Assessment for Masonry Fireplace Surrounds

Item	Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance step if Unknown
1	Masonry surrounds that extend vertically less than 4 feet above the finished floor or horizontally less than 3 feet from the edge of the <i>firebox</i> , OR	Retrofit of masonry surround is not required.	Provide detailed assessment or retrofit of masonry surround.	Provide detailed assessment or retrofit of masonry surround.
2	Masonry surrounds constructed on or after January 1, 1995.	Retrofit of masonry surround is not required.	Provide detailed assessment or retrofit of masonry surround.	Provide detailed assessment or retrofit of masonry surround.

7.3.5 Detailed Assessment of Masonry Fireplace Surrounds

Surrounds constructed prior to 1995 shall be deemed to comply with the requirements of this chapter without retrofit if a licensed contractor or registered design professional verifies that one of the following conditions are met:

1. *Anchored masonry fireplace surrounds* constructed prior to 1995 for which a licensed contractor or registered design professional verifies that all the following conditions are met:
 - a. Mortar is Portland cement based, fully intact, and exhibit only minor cracking.
 - b. Masonry units are fully intact, exhibit only minor cracking, and do not exceed 5 inch thickness.
 - c. Tie attachments support no more than two square feet of surround area.
 - d. Tie attachments to wood are, at minimum, 22-gage (0.0299-inch thick) and 7/8-inch wide corrugated sheet metal, or a 9-gage strand wire with a hook embedded in the mortar joint, fastened to the wood framing with at least one 8d ring shank nail. Tie attachments to steel studs are minimum 9-gage strand wire with a hook embedded in the

mortar joint, fastened with at least one No. 10 screw through the framing a minimum of three exposed threads.

- e. Wood or steel studs, including attachments to top and bottom plates, are designed to support the imposed loads.
2. *Adhered masonry fireplace surrounds* constructed prior to 1995 for which a licensed contractor or registered design professional verifies that all the following conditions are met:
- a. Mortar is Portland cement based, fully intact, and exhibit only minor cracking.
 - b. Each masonry veneer unit does not exceed 2-5/8 inches thickness, 36 inches length in either direction, or 5 square feet of wall surface area coverage (per unit).
 - c. The masonry wall covering weight does not exceed 15 pounds per square foot.
 - d. Veneer is adhered to continuous backing with a minimum shear strength of 50 pounds per square inch in accordance with ASTM C482.

7.4 Chimney Prescriptive Retrofit

This section provides seismic retrofit provisions for existing masonry chimneys.

Prior to retrofit any other flue(s) discharging products of combustion through the main chimney flue shall be first re-routed per the currently adopted building or residential code.

7.4.1 Scope

Existing masonry chimneys shall be retrofit in accordance with this section.

1. Exterior chimneys of dwellings of any height shall be demolished down to the base of the chimney at the lowest firebox.
2. Interior chimneys of dwellings of two or more stories shall be demolished down to the base of the chimney at the lowest firebox.
3. Interior chimneys having some portion more than 6 feet long not enclosed by full-height, finished walls on at least three faces, such as chimneys extending through a tall, unfinished *attic* space, shall be demolished down to the floor or ceiling immediately below the unenclosed portion.

4. Interior chimneys that extend more than twice the least plan dimension above the roof, and are not subject to the requirements of Item 3, shall be demolished down to the roof.
5. Chimneys demolished down to a roof, floor, or ceiling level shall be capped per Section 7.4.2.
6. Chimneys demolished down to the base shall be capped similar to Section 7.4.2 or rebuilt per Section 7.4.3 or Section 7.4.4.
7. Chimney demolished down to and including the foundation shall be permitted to be reconstructed in accordance with the adopted building or residential code, where permitted by the local jurisdiction.

7.4.2 Capping of Chimney at Roof, Floor, or Ceiling Level

This section provides prescriptive methods for partial removal and capping of masonry chimneys at the firebox, roof, or ceiling level.

7.4.2.1 Chimney Partial Removal and Capping

Chimneys demolished to the roof shall be removed to the top of the course of masonry just above the highest existing roof flashing, but not less than 7 inches, leaving the upper course undisturbed. A sheet metal *chimney cap* of galvanized steel or stainless steel shall be provided as shown in Figure 7.4-1. The cap shall extend not less than 3 inches down each side of the chimney, overlapping any existing flashing by at least 2 inches where it occurs. The cap shall be secured to the chimney with corrosion-resistant fasteners. New fasteners shall not penetrate existing flashing.

Chimneys demolished to a floor or ceiling level shall be removed to a distance of not more than 8 inches above the top of ceiling or floor framing. The chimney shall be capped with sheet metal as shown in Figure 7.4-2. The roof opening shall be closed and weatherproofed using framing and roofing materials to match the existing construction.

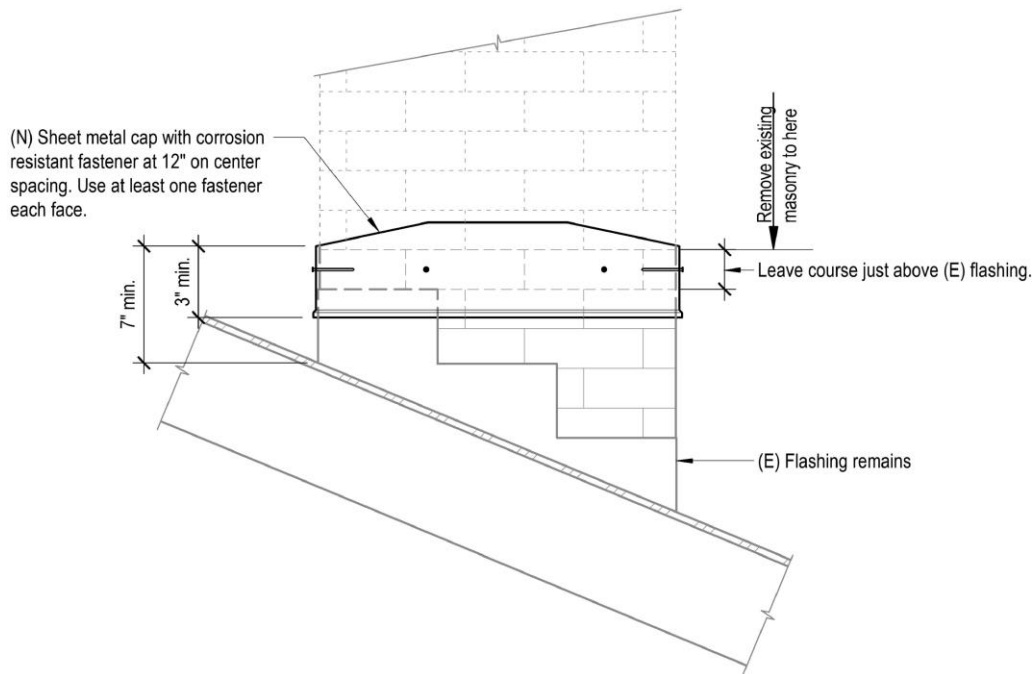


Figure 7.4-1 Capping of chimney removed to roof level (similar to chimney removed to top of firebox).

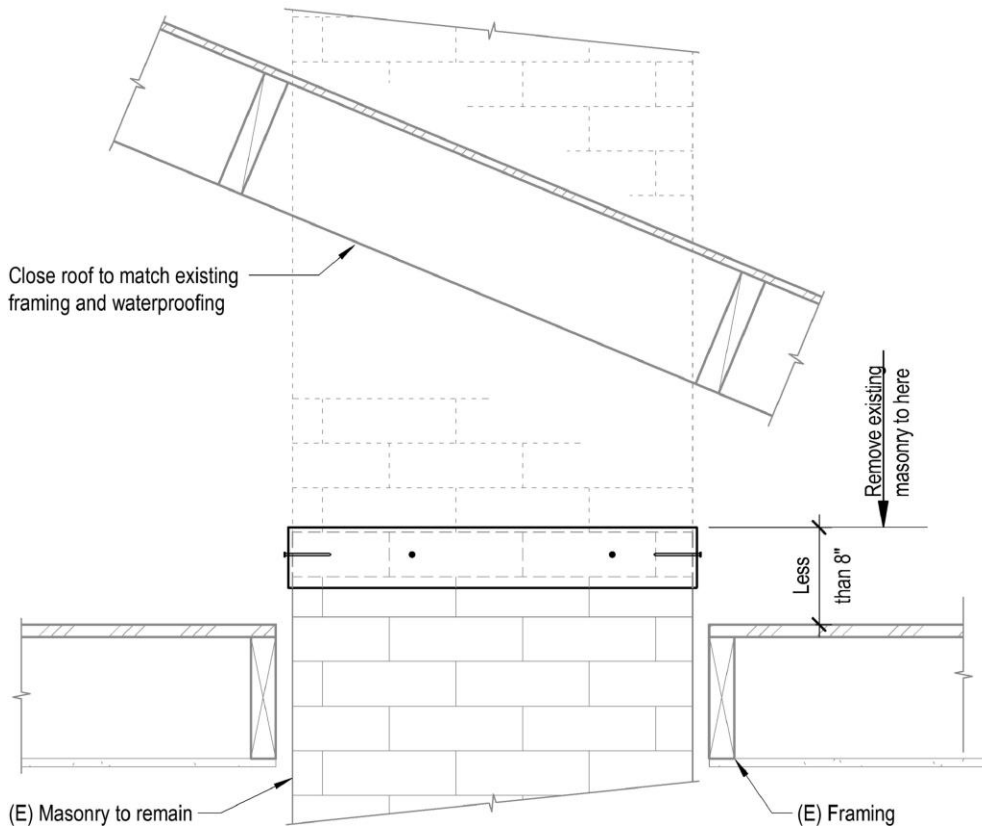


Figure 7.4-2 Capping of chimney removed to floor level (similar to chimney removed to ceiling level).

7.4.2.2 Interior of the Firebox

Access to the interior of the firebox shall be completely closed off from the dwelling interior with an infill of gypsum wallboard, wood structural panel sheathing, or masonry that is permanently affixed to the existing firebox or surrounding framing.

7.4.3 Reconstruction from the Chimney Base

This section provides prescriptive methods for removal of the masonry chimney to its base, and reconstruction using a *factory-built chimney* enclosed in a framed chimney chase.

7.4.3.1 Chimney Partial Removal

The chimney shall be removed down to its base as shown in Figure 7.4-3.

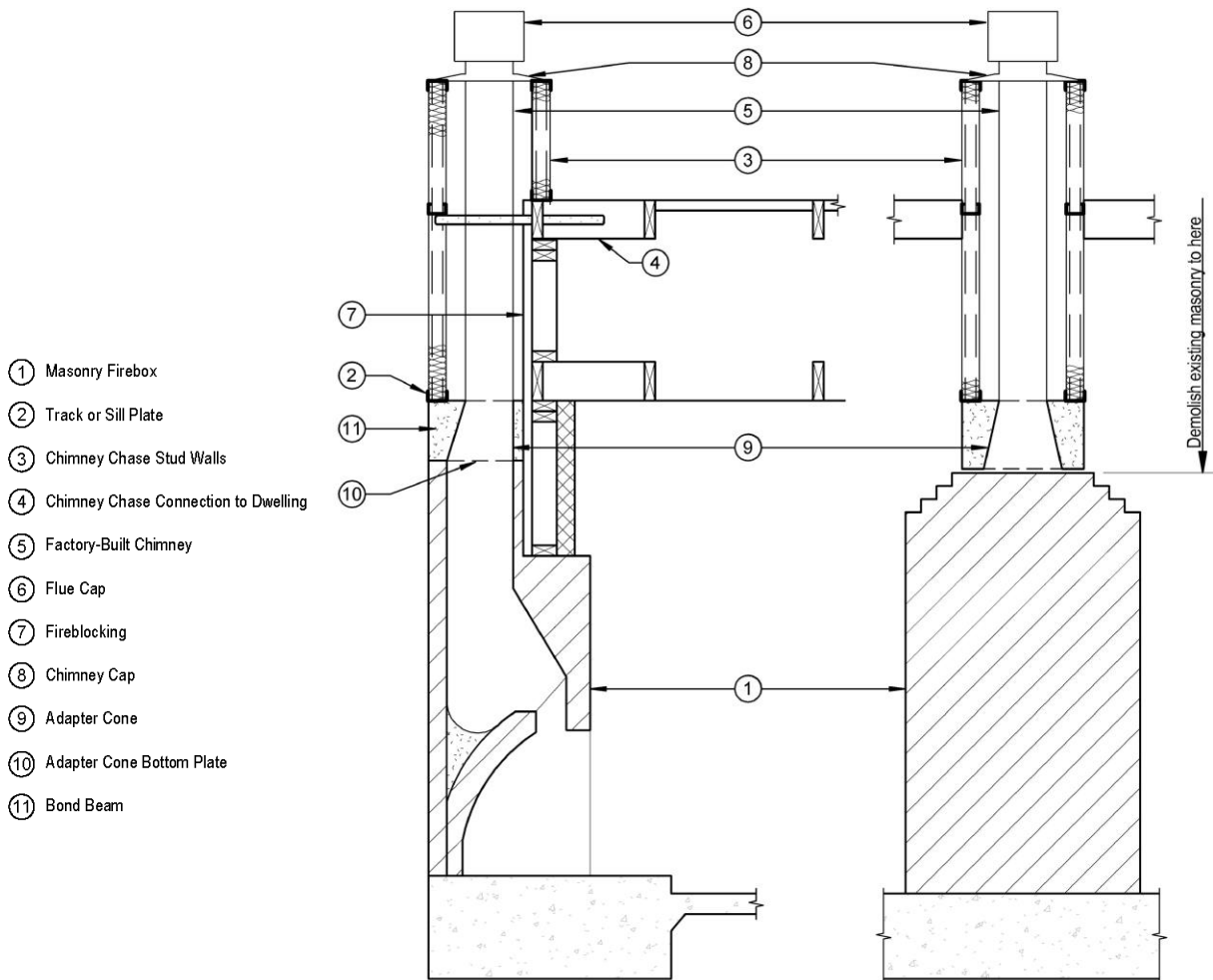


Figure 7.4-3 Components of a masonry firebox in combination with light-factory-built chimney and light-framed chimney chase.

7.4.3.2 Reconstruction

Reconstruction shall be in accordance with the factory-built chimney manufacturer's installation instructions, the requirements of this section, and Figure 7.4-3. All clearances required by the manufacturer and listing shall be maintained. The reconstruction shall incorporate a UL 103-listed, factory-built chimney with a masonry fireplace adapter, tested per UL 103A and listed for use with the specific factory-built chimney.

1. **Masonry firebox.** The existing masonry firebox shall remain up to the base of the flue as shown in Figure 7.4-3.
2. **Track or sill plate.** Cold-formed steel track sections matching the thickness of the studs shall be provided at the bottom of cold-formed steel chimney chase walls. Wood sill or sole plates having a width not less than the supported studs shall be provided at the bottom of wood chimney chase walls. Wood sill or sole plates shall be protected against decay by the use of *naturally durable wood* or wood that is *preservative treated*. Fasteners in contact with wood sill or sole plates shall be of hot-dipped, zinc-coated galvanized steel or of stainless steel. Tracks and sill or sole plates shall be anchored to the concrete beam per Figure 7.4-4.

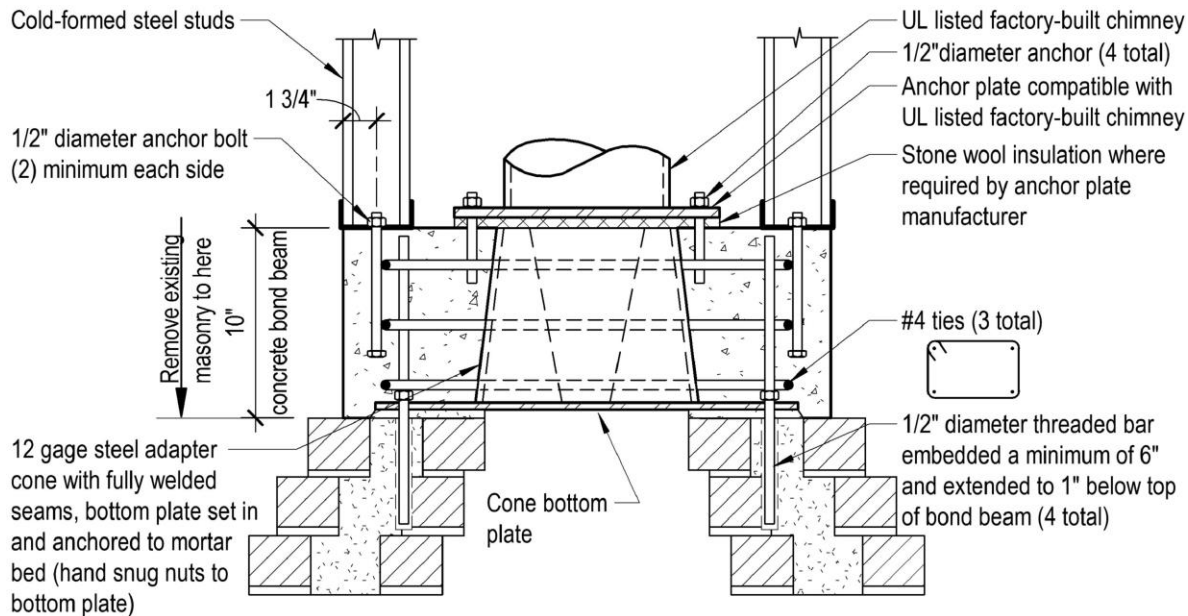


Figure 7.4-4 Transition between factory-built chimney and masonry fireplace.

3. **Chimney chase stud walls.** Chimney chases shall be constructed of full height studs spaced at no more than 12 inches on center. Stud sizes shall be selected based on story-to-story height. Wood studs shall not be less than nominal two-inch by three-inch. Cold-formed steel studs shall be not less than 43 mil thickness (18 gage) by 2-1/2 inches deep. The top of

the chimney chase shall extend not less than 3 feet above the edge of the roof and not less than 2 feet above the maximum roof elevation, or maximum elevation of other construction located within a 10-foot horizontal dimension in any direction from the chimney (Figure 7.4-5). Where the exterior walls adjacent to the chase are less than 5 feet from the lot line, they shall be constructed with full 2×4 wood or 54 mil (16 gage) 3 5/8-inch steel studs with exterior sheathing that includes 7/8-inch thick conventional stucco or minimum 1/2-inch thick Type X gypsum sheathing. Additional fire protection requirements in the currently adopted building or residential code shall be confirmed with the building official. The chimney chase shall be capped, with roofing and flashing to be weatherproof and to match existing construction.

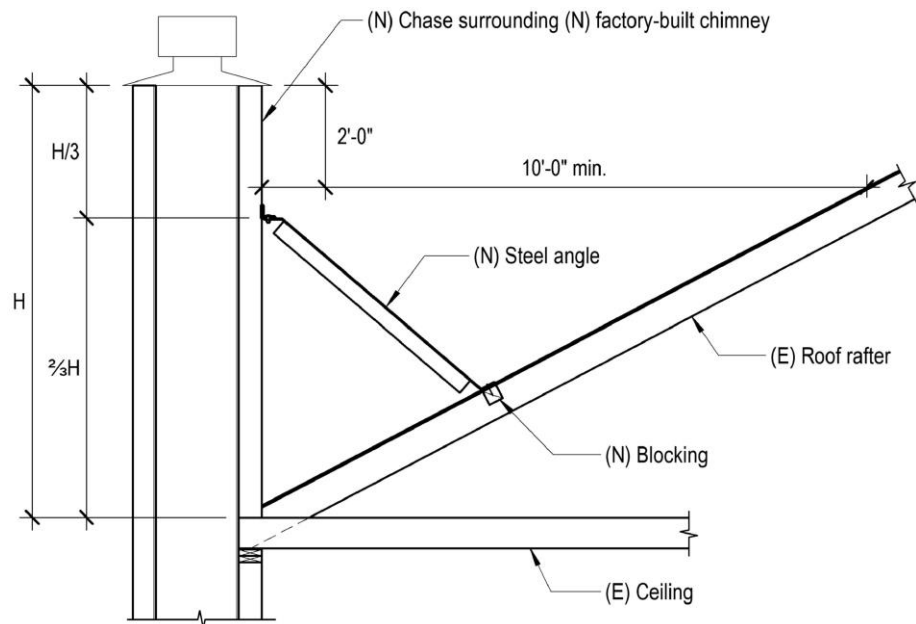


Figure 7.4-5 Brace for new chase, where H exceeds 4 feet.

4. **Chimney chase connection to dwelling.** The chimney chase studs shall be fastened to the existing residence exterior wall with minimum No. 8 wood screws at 12 inches on center. The chimney chase framing shall be strapped to the existing floor, ceiling, and roof framing with not less than two steel straps 1-1/4 inches minimum in width and 33 mil (20 gage) minimum in thickness, with each strap located on an opposing face of the chase. Each strap shall be fastened to steel blocking between steel studs of the chimney chase with minimum four No. 8 sheet metal screws, or to wood blocking between wood studs of the chimney chase with not less than four 8d common nails. Each strap shall be fastened to existing steel floor, roof, or ceiling framing with minimum four No. 8 sheet steel screws, or to existing wood floor, ceiling or roof framing with minimum

four 8d common nails. Where chimney chase stud walls extend more than 4 feet above the highest roof elevation immediately adjacent to the chimney, bracing shall be provided in accordance with this section or in a manner acceptable to the building official. The bracing shall be connected to the chimney chase in the upper third of the chase clear height above the roof ($H/3$ as shown in Figure 7.4-5). Bracing steel angles shall be galvanized or otherwise corrosion resistant and not less than 2-1/2×2-1/2×1/4-inch installed per Figure 7.4-6. Not less than two braces shall be provided. The bracing slope shall be not less than 30 degrees and not more than 60 degrees from vertical.

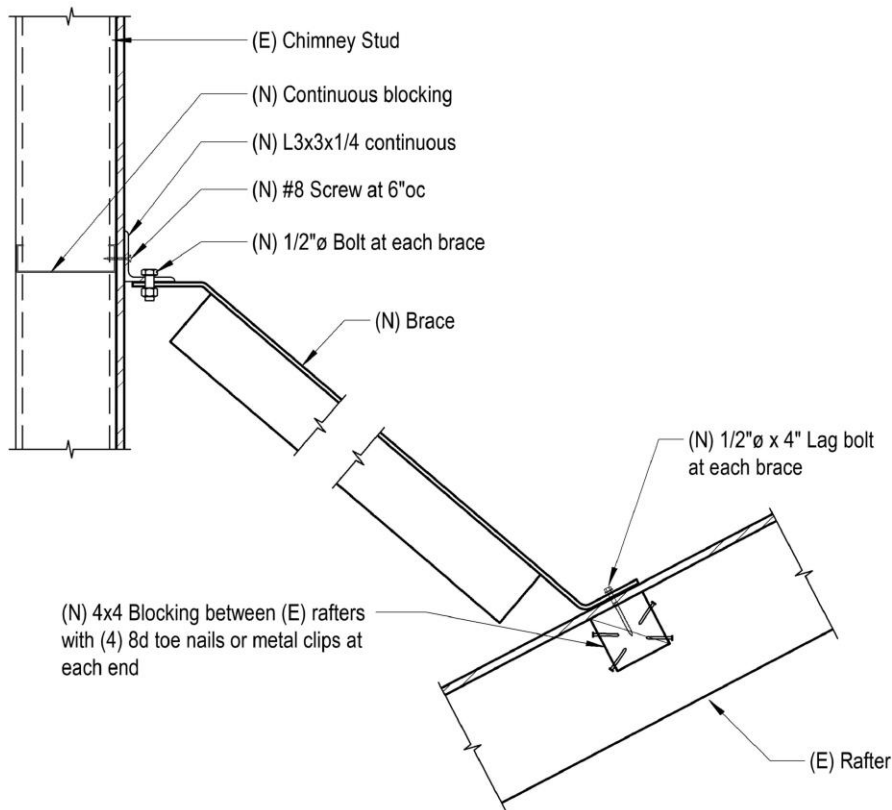


Figure 7.4-6 Brace connection for new chase.

5. **Factory-built chimney.** Factory-built chimneys shall be sized such that round chimney flues shall have a minimum net cross-sectional area of not less than 1/12 of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of 1/10 of the fireplace opening. Rectangular chimney flues with an aspect ratio less than 2 to 1 shall have a minimum net cross-sectional area of 1/10 of the fireplace opening. Rectangular chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of 1/8 of the fireplace opening. Factory-built chimneys shall be listed and *labeled* and shall be installed and terminated in accordance with the manufacturer's instructions.

Decorative shrouds shall not be installed at the termination of factory-built chimneys except where the shrouds are listed and labeled for use with the specific factory-built chimney system and installed in accordance with the manufacturer's instructions. No part of the chimney shall be at an angle of more than 30 degrees (0.52 rad) from vertical at any point in the assembly and the chimney assembly shall not include more than four elbows.

6. **Flue cap.** Factory-built cap installed in accordance with manufacturer's instructions and complying with the metal chimney UL listing.
7. **Fireblocking.** Spaces between chimneys and floors and ceilings through which chimneys pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between chimneys and wood joists, beams or headers shall be self-supporting or be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney. Draft stops consisting of drywall, plywood, or OSB shall be provided to separate the chase from wood framing of the dwelling.
8. **Chimney cap.** A framed chimney cap shall be constructed at the top of the chimney chase.

7.4.3.3 Chimney Transition

The transition to the factory-built chimney and chimney chase shall be in accordance with the factory-built chimney manufacturer's installation instructions, the following requirements, and Figure 7.4-4.

1. **Adapter cone.** A 12 gage (97 mil) minimum thickness galvanized sheet steel adapter cone shall be provided. The cone shall have minimum 12 gage (97 mil) thickness sheet steel top and bottom plates, and shall provide a smooth-surfaced transition between the flue opening from the top of the firebox and into the flue. The bottom plate geometry shall match the masonry opening, and the anchor plate geometry shall be coordinated with the flue. The adapter cone shall be set in cementitious grout, and all cone seams shall be continuously welded.
2. **Cone bottom plate.** The adapter cone bottom plate shall be anchored to the masonry with not less than four 1/2-inch diameter galvanized threaded rod anchors. The threaded rods shall extend upward to 1 inch below the top of the concrete beam, shall be embedded 6 inches into masonry and shall be set in cementitious mortar.
3. **Bond beam.** A reinforced concrete beam shall be constructed around the adapter cone, using the cone as the inside form. A minimum 1-1/2 inch

cover shall be maintained between the reinforcing steel and the outside face of concrete.

7.4.4 Reconstruction from Chimney Base using a Factory-Built Fireplace Insert

This section provides prescriptive methods for partial removal of the masonry chimney and reconstruction using a *factory-built fireplace insert* with a factory-built chimney enclosed in a light-framed chimney chase.

7.4.4.1 Chimney Partial Removal

The chimney shall be removed down to its base as shown in Figure 7.4-7.

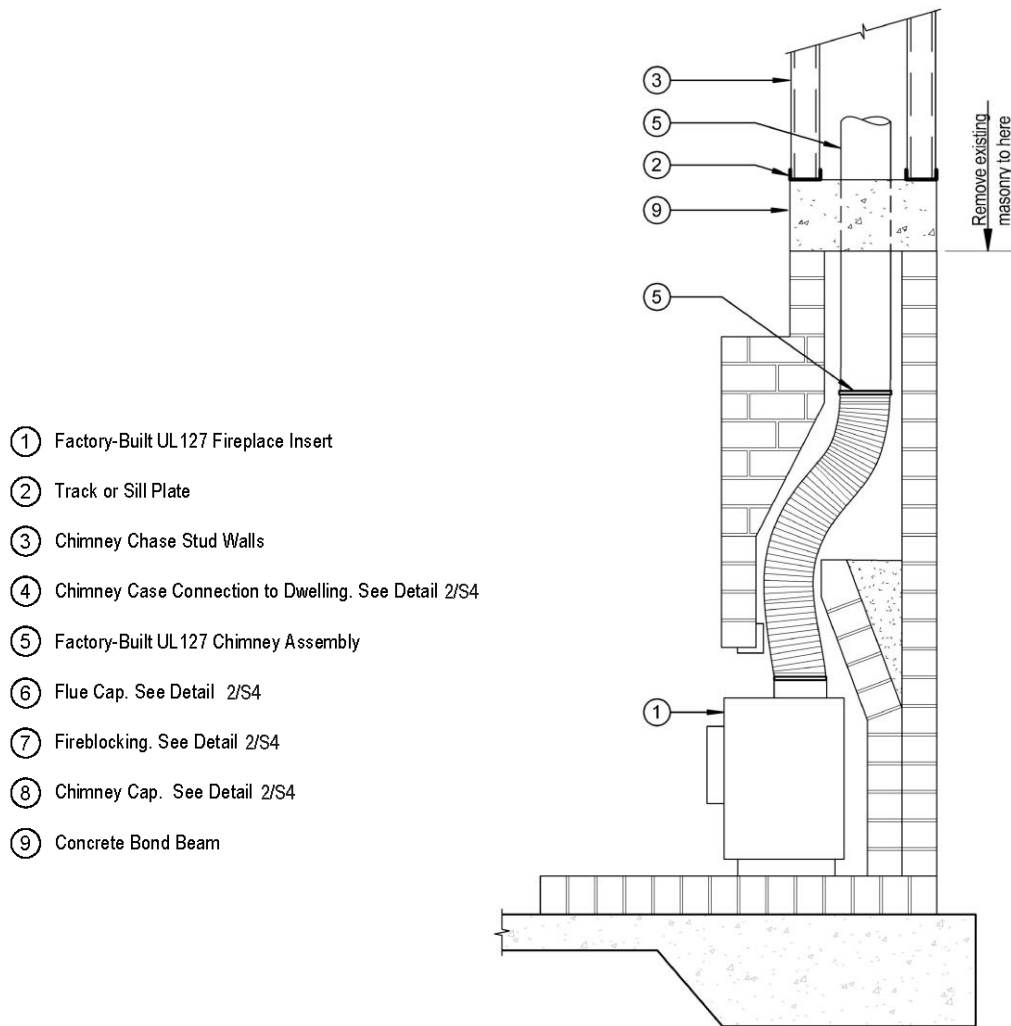


Figure 7.4-7 Transition to chimney where factory-built fireplace insert is used.

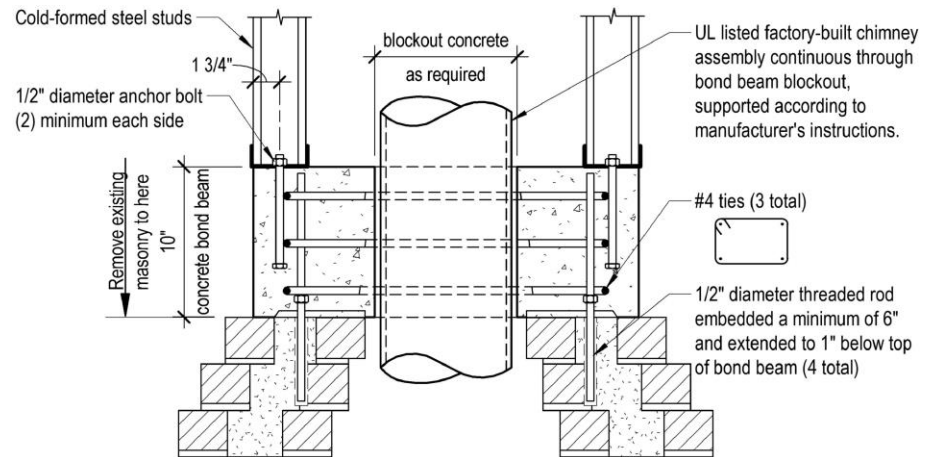
7.4.4.2 Reconstruction

Reconstruction shall be in accordance with the insert manufacturer's installation instructions, the requirements of this section, and Figure 7.4-7.

All clearances required by the manufacturer and listing shall be maintained. The reconstruction shall incorporate a factory-built, UL 127-listed insert and chimney. Reconstruction shall be in accordance with Items 2 through 8 of Section 7.4.3.2.

7.4.4.3 Insert-to-Chimney Transition

The insert and chimney shall be an uninterrupted, UL listed, factory-built assembly installed per the manufacturer's instructions. The transition from masonry to light-framed chimney chase shall be per the requirements of this section and Figure 7.4-8.



Note: Material used to form and blockout concrete bond beam to allow passage of factory-built chimney assembly must be completely removed after concrete has cured.

Figure 7.4-8 Masonry transition to chimney chase where factory-built fireplace insert is used.

A reinforced concrete beam shall be constructed at the base of the chimney chase as shown in Figure 7.4-7. A minimum 1-1/2-inch cover shall be maintained between the reinforcing steel and the outside face of concrete. The bond beam shall be blocked-out to allow minimum 1/2-inch free space between the concrete and the factory-built chimney assembly. Any material used to form block-out must be completely removed after concrete cure.

7.4.5 Full Reconstruction of Firebox and Chimney Using Factory-Built Components

This section provides prescriptive methods for removal of the masonry chimney and firebox, and reconstruction using a factory-built chimney enclosed in a chimney chase. Use of these provisions is limited to exterior chimneys. Alternatively, interior or exterior chimneys shall be permitted to be fully reconstructed in accordance with the adopted building or residential code.

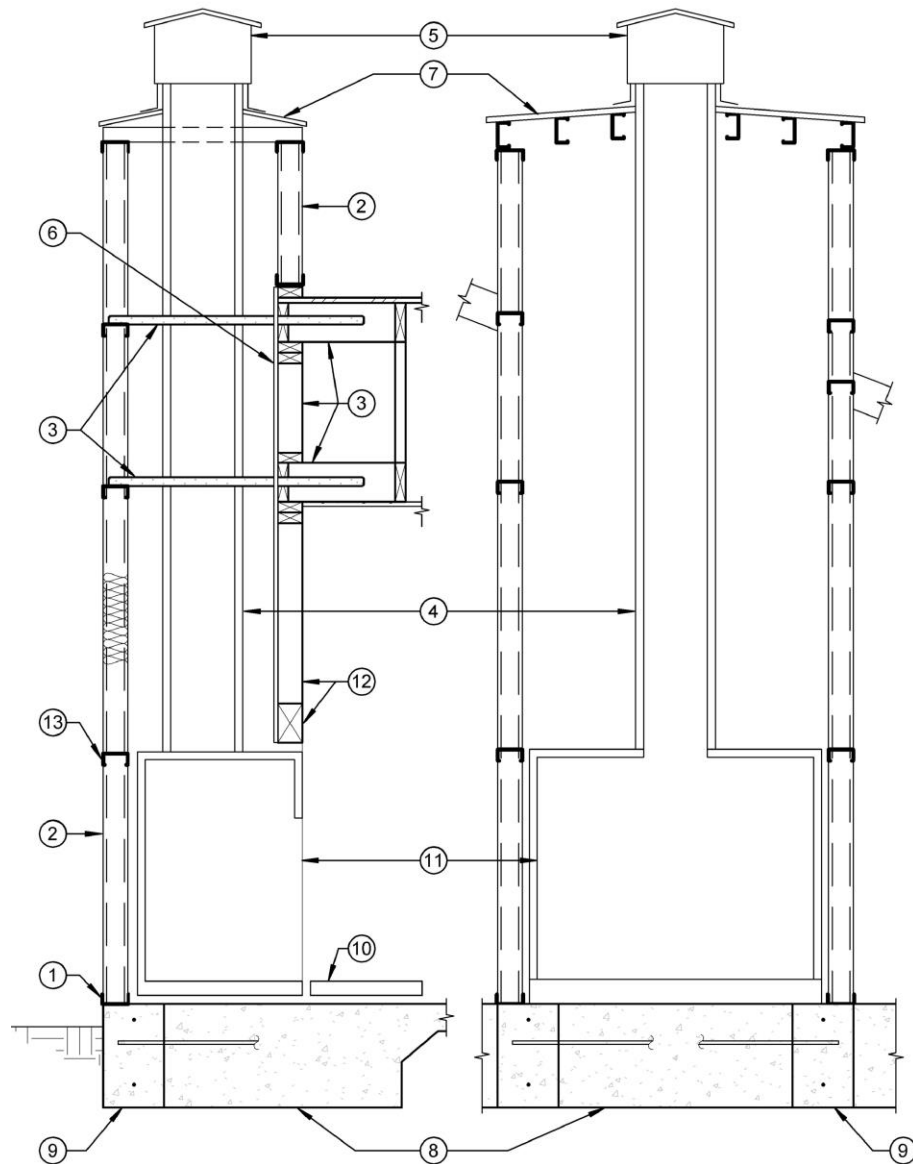
7.4.5.1 Chimney and Firebox Removal

The chimney and firebox shall be completely removed.

7.4.5.2 Reconstruction

Reconstruction shall be in accordance with the factory-built fireplace manufacturer's installation instructions, Items 2 through 8 of Section 7.4.3.2 and the following requirements as shown in Figure 7.4-9.

1. **Existing foundation.** An existing concrete foundation in good condition is permitted to be retained and incorporated. Where the existing foundation is deemed to be in poor condition or constructed of material other than concrete, it shall be removed and replaced in accordance with the fireplace manufacturer and this section. At minimum, the footings shall be constructed of concrete not less than 12 inches thick and shall extend not less than 6 inches beyond the face of the fireplace or foundation wall on all sides. Foundations shall be founded on natural, undisturbed earth or engineered fill below frost depth, but not less than 12 inches below finished grade.
2. **Extension of existing foundation.** Where required to meet dimensional requirements specified by the fireplace manufacturer or the requirements in Item 1 above, the existing concrete footing shall be extended as shown in Figure 7.4-9. The depth of the new foundation shall match the depth of the existing foundation, but the bottom of the foundation shall not be less than 12 inches below grade. The foundation extension shall be reinforced with one No. 4 bar top and bottom and epoxy dowels into the existing foundation spaced not more than 12 inches on center.
3. **Non-combustible hearth extension.** Where required to meet manufacturer's requirements or fireplace listing, a hearth extension listed and *labeled* per UL 1618 shall be provided.
4. **Factory-built fireplace.** Factory-built fireplaces shall be listed, labeled, and installed per the conditions of the listing.
5. **Existing framing.** Existing roof, wall, and ceiling framing shall remain. Where existing wall framing requires modification to accommodate a new fireplace opening, it shall be verified to be in good condition and in accordance with conventional construction provisions. New framing shall match existing construction.
6. **Stud blocking.** Continuous blocking between new studs shall be installed at 4 foot maximum vertical spacing. Blocking size shall match studs.



- | | |
|---|-------------------------------------|
| ① Track or Sill Plate. | ⑧ Existing Foundation. |
| ② Chimney Chase Stud Walls. | ⑨ Extension of Existing Foundation. |
| ③ Chimney Chase Connection to Dwelling. | ⑩ Non-combustible Hearth Extension. |
| ④ Factory-built Chimney. | ⑪ Factory-built Fireplace. |
| ⑤ Flue Cap. | ⑫ Existing Framing. |
| ⑥ Fireblocking. | ⑬ Stud Blocking. |
| ⑦ Chimney Cap. | |

Figure 7.4-9 Components of a factory-built fireplace in light-frame chimney.

7.5 Masonry Fireplace Surround Prescriptive Retrofit

In lieu of an engineered retrofit by a registered design professional, noncompliant masonry fireplace surrounds can be removed and reconstructed as anchored masonry veneer meeting the all of the following requirements:

1. Mortar shall be ASTM C270 Type S.
2. Masonry units shall not exceed 5 inches thickness.
3. Tie attachments shall support no more than two square feet of tributary wall area.
4. Tie attachments to wood shall be, at minimum, 22-gage (0.0299-inch thick) and 7/8-inch wide corrugated sheet metal, or 9-gage strand wire with a hook embedded in the mortar joint, fastened to the wood framing with an 8d ring shank nail. Tie attachments to steel studs shall be minimum 9-gage strand wire with a hook embedded in the mortar joint, fastened with a No. 10 screw through the framing a minimum of three exposed threads. A registered design professional shall check the strength of supporting wall studs, including attachments to top and bottom plates, to support all imposed loads.

7.6 Engineered Retrofit of Masonry Chimneys

Engineered retrofit of reinforced masonry chimneys shall conform to the requirements of Section 7.6.1 or Section 7.6.2. Engineered retrofit of unreinforced masonry chimneys shall conform to the requirements of Section 7.6.2.

Any flue(s) discharging products of combustion through the chimney shall be first re-routed per all requirements of the currently adopted building or residential code.

7.6.1 Building Code-Based Retrofit

Where the seismic weight of a chimney is greater than or equal to 25 percent of the effective seismic weight of the dwelling, the chimney retrofit shall be designed as a nonbuilding structure in accordance with the currently adopted building or residential code. Other masonry chimney retrofits shall be designed as a nonstructural component, anchored to and braced by the dwelling in accordance with ASCE/SEI 7 and the additional requirements of this section. Seismic loads shall be determined as either 75 percent of those specified by ASCE/SEI 7 for new construction, or those specified by the latest edition of ASCE/SEI 41 for the BSE-1E hazard level.

1. The seismic design force for the anchor straps shall be no less than F_p as defined for nonstructural components by ASCE/SEI 7.
2. Unless adequate strength of the foundation, soil, and chimney anchorage can be shown by calculation based on site conditions, anchor strap forces between the chimney and dwelling structure shall be calculated assuming zero resisting moment at the chimney base. For chimneys anchored at more than one diaphragm level, the chimney may be assumed rigid.
3. New chimney anchor straps shall wrap or otherwise engage the chimney. If existing embedded anchor straps are being used as part of the retrofit, engagement with the longitudinal chimney reinforcement shall be verified to conform to ASCE/SEI 7 provisions for flat strap anchorage of nonstructural components by exposing at least one anchor strap.
4. Connections of anchor straps to the diaphragm framing shall be designed per the currently adopted building or residential code.
5. Diaphragms supporting chimney anchor straps shall be evaluated pursuant to ANSI/AWC SDPWS, including collectors, where required to distribute diaphragm shear. The use of subdiaphragms designed to carry chimney anchor strap forces is acceptable.
6. The capacity of the reinforced chimney to carry moment and shear shall be determined according to TMS 402.
7. Retrofit design calculations and drawings shall be prepared by a registered design professional and submitted for approval to the building official.
8. All aspects of the construction shall require structural observation and shall be clearly stated as such on the design drawings and communicated to the contractor.

7.6.2 Performance-Based Retrofit

Masonry chimney retrofits designed according to ASCE/SEI 41 using a Partial Retrofit Objective with Life Safety Nonstructural Performance Level N-C are deemed to be in compliance with this chapter. Forces in anchor straps between chimney and dwelling shall be determined using dynamic analysis using a model that considers the mass, stiffness and damping of the dwelling, chimney and anchor straps separately. The properties and acceptance criteria for the various materials including the unreinforced or reinforced masonry chimney, steel anchor straps, anchor strap connections to light-framed diaphragms and shear walls shall be taken from the appropriate chapters of ASCE/SEI 41.

Chapter 8

Detailed Vulnerability-Based Assessment

The detailed vulnerability-based assessment provisions of this chapter shall be used when required by provisions in Chapters 4 through 6. Those elements that are in compliance with the simplified assessment of Chapter 4 or 5 or those that will be retrofit need not be assessed in accordance with this section.

8.1 Foundation

The foundations at the dwelling perimeter, not including porches or other unenclosed appurtenances, shall be assessed in accordance with this section.

1. Where there is a continuous concrete or masonry foundation, or continuous grade or tie-beams that are part of a deep foundation system at the dwelling perimeter, the foundation shall be assessed in accordance with Table 8.1-1. Where the foundation is compliant with all the assessment statements, the foundation shall be deemed in compliance with this section. Where the foundation is non-compliant with one or more assessment statements, the foundation shall be retrofit. Where it is possible to repair the non-compliant condition or conditions, repair to bring the condition into compliance shall be permitted.
2. Where there is a wood foundation, the foundation shall have an engineered vulnerability-based assessment or a general engineered assessment.
3. Where there is a discontinuous pier foundation with deep piers including drilled piers and caissons not connected at the dwelling perimeter with grade or tie-beams, the foundation shall have a general engineered assessment.
4. Where there is a discontinuous foundation with shallow piers or pier blocks, the foundation shall be retrofit in accordance with Chapter 4 through Chapter 6 as applicable, or shall have an engineered vulnerability-based assessment or a general engineered assessment.
5. Where there is no foundation, retrofitting to add a foundation shall be provided in accordance with Chapters 4 through Chapter 6, as applicable.

Table 8.1-1 Foundation (F) Assessment Checklist

Item	Assessment Statement	Compliant	Non-Compliant
F1	Foundation is in moderate to good condition, with any reduction in cross sectional area of the existing concrete or masonry and of any existing reinforcing due to deterioration is limited to 20% of its original area.		
F2	Individual foundation cracks are less than 1/2 inches in width. In addition, multiple vertical or diagonal cracks greater than 1/4 inch wide are not closer than 4 feet on center.		
F3	There is no projection of cracking greater than 1/4 inch width into the wall or floor systems above.		
F4	There is no undermining of supporting soils below the existing foundation system greater than 4 square feet at any single location.		
F5	There is no continuous horizontal spalling due to badly corroded horizontal reinforcing measuring more than 16 inches in length in the <i>perimeter foundation</i> .		

8.2 Foundation Sill Plate Anchorage to Foundation

The *foundation sill plate* to foundation anchorage at the dwelling perimeter, not including porches or other unenclosed appurtenances, shall be assessed in accordance with this section.

Anchorage need not be assessed at foundations cast monolithically with the *slab-on-ground* in dwellings or portions of dwellings constructed in 1950 or later, if anchorage is behind wall finishes.

1. Where there are existing anchor bolts, the anchor bolts shall be assessed in accordance with Table 8.2-1. Where these anchor bolts are compliant with all assessment statements, the foundation anchorage shall be deemed in compliance with this chapter. Where the foundation anchorage is non-compliant with one or more assessment statements, the anchorage shall be retrofit.
2. Where there are proprietary retrofit anchors, the anchors shall be assessed in accordance with Table 8.2-2. Where the foundation anchorage is compliant with all assessment statements, the foundation anchorage shall be deemed in compliance with this chapter. Where the foundation anchorage is non-compliant with one or more assessment statements, the foundation anchorage shall be retrofit.

Table 8.2-1 Anchor Bolt (AB) Assessment Checklist

Item	Assessment Statement	Compliant	Non-Compliant
AB1	Anchor bolts installed as part of original construction are 1/2 inch in diameter or larger with on average spaced not more than 6 feet on center for one-story dwellings and four feet on center for two-story dwellings, and are provided for the full extent of the perimeter foundation.		
AB2	Anchor bolts installed as part of a previous seismic retrofit are 1/2 inch in diameter or larger with on average spaced not more than 64 inches on center for one-story dwellings and 32 inches on center for two-story dwellings, and are provided for the full extent of the perimeter foundation.		
AB3	Anchor bolts installed as part of original construction shall have nuts, whether bearing directly on sill or having a gap between nut and sill. Nuts are to be threaded sufficiently to engage at least 2/3 of the nut height.		
AB4	Anchor bolts installed as part of a previous seismic retrofit shall have a minimum 2"×2"×3/16" steel plate washers.		
AB5	<p>No more than 10% of the anchor bolts have reduced capacity due to one or more of the following conditions, and</p> <p>No more than 20% of the anchor bolts on a particular wall line have reduced capacity due to one or more of the following conditions:</p> <ul style="list-style-type: none"> • Decay of the foundation sill plate in the immediate vicinity of the anchor bolt • Corrosion of the anchor bolt reducing the bolt cross sectional area by 20% or more • Placement of the anchor bolt centerline closer than 1-1/4 inches to the face of foundation sill plate or face of foundation • Countersinking of the washer or nut into the foundation sill plate such that the sill plate is less than one inch high at the anchor bolt location • Post-installed anchors with visible indications that they are not properly installed 		

Table 8.2-2 Proprietary Anchor (PA) Assessment Checklist

Item	Assessment Statement Description	Compliant	Non-Compliant
PA1	Proprietary anchors that have published capacities of not less than 875 pounds for shear along the length of the foundation of at least and on average spaced at not		

	more than 64 inches on center for one story dwellings and 32 inches on center for two story dwellings.		
PA2	Proprietary anchors are installed in accordance with manufacturer's installation instructions.		
PA3	Proprietary anchors and the elements to which they are directly attached have not significantly deteriorated.		

3. Where there is another anchorage type other than anchor bolts or proprietary retrofit anchors, an engineered vulnerability-based assessment, or a general engineered assessment shall be provided.
4. Where there is no anchorage, anchorage retrofit shall be provided.

8.3 Bracing Wall Sheathing

Cripple wall or crawlspace wall sheathing at the perimeter of a crawlspace dwelling or hillside dwelling crawlspace shall be assessed in accordance with this section. Bracing wall sheathing in the ground story of living-space-over-garage dwellings shall be assessed in accordance with Section 8.5.

1. Where there is plywood panel siding, the siding shall be assessed in accordance with Table 8.3-1. Where panel siding is found to be compliant with the assessment statements, the siding shall be deemed in compliance with this chapter. Where the panel siding is non-compliant with one or more of the assessment statements, the siding shall be retrofit. Where it is possible to repair the non-compliant condition, repair to bring the condition into compliance is permitted.
2. Where there is existing plywood or orientated strand board (OSB) sheathing installed as part of the original construction, the existing plywood or OSB shall be assessed in accordance with Table 8.3-2. Where the plywood or OSB sheathing is found to be compliant with all assessment statements, the sheathing shall be deemed in compliance with this chapter. Where the plywood or OSB is non-compliant with one or more of the assessment statements, the sheathing shall be retrofit.
3. Where there is existing plywood or OSB sheathing installed as part of a previous seismic retrofit, the existing plywood or OSB shall be assessed in accordance with Table 8.3-3. Where the plywood or OSB is found to be compliant with all assessment statements, the sheathing shall be deemed in conformance with this chapter. Where the plywood or OSB is non-compliant with one or more of the assessment statements, the sheathing shall be retrofit. Where it is possible to repair the non-compliant condition, repair to bring the condition into compliance is permitted.

Table 8.3-1 Exterior Plywood Panel Siding (PS) Assessment Checklist

Item	Assessment Statement	Compliant	Non-Compliant
PS1	All perimeter cripple walls or crawlspace walls are continuously sheathed with plywood panel siding except for ventilation and access openings.		
PS2	The siding is in good condition, with no significant deterioration or damage.		
PS3	The sheathing is nailed with not less than 6d common nails (2" x 0.113") for 1/2-inch sheathing and 8d common nails (2-1/2" x 0.131") for 5/8-inch sheathing.		
PS4	The sheathing is edge nailed at not more than 6 inches on center at the full perimeter of each sheathing sheet and a minimum 3/8 inches edge distance is maintained for the full siding thickened at the edge each panel for 6d or 8d common nails.		
PS5	The sheathing is field nailed at not more than 12 inches on center.		

Table 8.3-2 Wall Sheathing from Original Construction (OC) Assessment Checklist

Item	Assessment Statement	Compliant	Non-Compliant
OC1	All perimeter cripple walls or crawlspace walls are continuously sheathed in plywood or oriented strand board (OSB) <i>wood structural panel</i> sheathing except for ventilation and access openings.		
OC2	The sheathing is in good condition, with no significant deterioration or damage.		
OC3	The sheathing is not less than 3/8-inch thick.		
OC4	There is no visible indication that the sheathing installation does not conform with general construction practice or edge nail spacing is greater than six inches on center.		

4. Where there is another type of panel or siding product, the panel or siding shall have an engineered vulnerability-based assessment or a general engineered assessment, or be retrofit.
5. Where there is no plywood or OSB sheathing, retrofit shall be provided in accordance with Chapter 4.

8-3 Existing Wall Sheathing from Previous Retrofit (PR) Assessment Checklist

Assessment Statement	Compliant	Non-Compliant
The length of cripple wall sheathing (crawlspace dwellings) provided at each exterior wall line is not less than required by Table 8.3-4 and does not exceed 4'-0" in height., OR The length of crawlspace wall sheathing (hillside dwellings) is not less than 80% of the accessible crawlspace wall length at each perimeter crawlspace wall line.		

PR2	The plywood or OSB sheathing is in good condition, with no significant deterioration or damage.		
PR3	The sheathing is not less than 3/8-inch thick.		
PR4	The sheathing is nailed with not less than 8d nails.		
PR5	The sheathing is edge nailed at not more than 4 inches on center at the full perimeter of each sheathing sheet and a minimum 3/8 inch edge distance is maintained at the edge each panel for 8d common nails.		
PR6	The sheathing is field nailed at not more than 12 inches on center.		
PR7	The sheathing extends the full height of the cripple wall and is edge nailed to the foundation sill and the top plate.		
PR8	The framing to which the sheathing is attached has not been compromised by deterioration or will be replaced to its original condition.		
PR9	The perimeter cripple wall is enclosed by finish materials over only a limited area of an otherwise unfinished crawlspace.		

Table 8.3-4 Minimum Required Retrofit Sheathing Length [IEBC Table A3-1]

Number of Stories Above Cripple Wall	Amount of Bracing Each Perimeter Cripple Wall	
	Dwellings with a Combination of Exterior Walls finished with Stucco and a Roofing System using Clay or Concrete Tiles Weighing more than 6 psf	All Other Conditions
One	Each end and not less than 50% of wall length	Each end and not less than 40% of wall length
Two	Each end and not less than 70% of wall length	Each end and not less than 50% of wall length

8.4 Floor Framing Rim Joist and Blocking

The connection of dwelling floor framing to the cripple wall below shall be assessed in accordance with this section. Where the dwelling sits directly on a foundation sill plate without a cripple wall, the connection of the dwelling floor framing to the foundation sill plate below shall also be assessed in accordance with this section.

1. The rim joist and or blocking at the perimeter of the crawlspace shall be assessed in accordance with Table 8.4-1 for one story dwelling and Table 8.4-2 for two story dwelling, respectively. When at all locations either blocking or a rim joist are present as specified in Table 8.4-1 or Table 8.4-2, and existing or retrofitted connections are found to be compliant with all assessment statements, the existing connections for the rim joist or blocking shall be deemed to meet the requirements of this section. At any location where either the blocking, rim joist, or existing connection are non-compliant with one or more of the assessment statements, retrofit

shall be provided. Where existing connections as specified in Table 8.4-1 and Table 8.4-2 cannot be verified, retrofit will be required.

Table 8.4-1 Rim Joist and or Blocking (RJB1) Assessment Checklist—One-Story Dwelling

Item	Assessment Statement	Compliant	Non-Compliant
RJB1-1	At the perimeter of the dwelling, either a continuous rim joist or floor joist blocking in all or alternate joist bays shall occur directly on top of perimeter foundation sill plate or cripple wall top plate and shall have full bearing.		
RJB1-2	Continuous rim joists and blocking are in good condition with no significant deterioration.		
RJB1-3	For assessment of original construction, continuous rim joists or blocking are attached to the continuous cripple wall top plates or foundation sill plate below with a minimum of 8d common toenails at 12 inches on center.		
RJB1-4	For assessment of previous retrofit construction, <i>connectors</i> (shear clips) have been provided between the existing continuous rim joist or blocking to the cripple wall top plates or foundation sill plate below, spaced at not more than 32 inches on center and shall have a manufacturer’s listed ASD capacity of not less than 450 pounds per connector in load direction parallel to the length of the foundation.		

**Table 8.4-2 Rim Joist and or Blocking (RJB2) Assessment Checklist—
Two-Story Dwelling**

Item	Assessment Statement	Compliant	Non-Compliant
RJB2-1	At the perimeter of the dwelling, either a continuous rim joist or floor joist blocking in all joist bays shall occur directly on top of perimeter foundation sill plate or cripple wall top plate and shall have full bearing.		
RJB2-2	Continuous rim joists and blocking are in good condition with no significant deterioration.		
RJB2-3	For assessment of original construction, continuous rim joists or blocking are attached to the continuous cripple wall top plates or foundation sill plate below with a minimum of 8d common toenails at 6 inches on center.		
RJB2-4	For assessment of previous retrofit construction, connectors (shear clips) have been provided between the existing continuous rim joist or blocking to the cripple wall top plates or foundation sill plate below, spaced at not more than 16 inches on center and shall have a manufacturer’s listed ASD capacity of not less than 450 pounds per connector in load direction parallel to the length of the foundation.		

8.5 Requirements for Ground Story Bracing Walls for Living-Space-Over Garage Dwellings

Bracing walls throughout the ground story of *living-space-over-garage dwellings* shall be assessed in accordance with one of the methods provided in this section. Where the bracing walls are compliant with one of the methods in this section, the bracing walls shall be deemed in compliance with this section. Where the bracing walls are non-compliant, the bracing walls shall be retrofit.

8.5.1 1994 or 1997 UBC Conventional Construction Provisions

Existing ground story bracing walls being checked for compliance with the 1994 or 1997 Uniform Building Code (UBC) conventional construction provisions shall conform to all of the following:

1. *Braced wall lines* in each horizontal direction shall not exceed the on-center spacing specified in Table 8.5-1.
2. *Braced wall panels* in each braced wall line shall conform to the type, placement, and minimum length specified in Table 8.5-2.

3. Construction of braced wall panels shall meet the provisions of Table 8.5-3.
4. Minimum lengths of braced wall panels shall meet the provisions of Table 8.5-4.
5. Bracing shall be in good condition with no significant deterioration or damage.

Table 8.5-1 Maximum on-Center Spacing of Braced Wall Lines (Based on 1997 UBC Sec. 2320)

Seismic Design Category	Maximum on-Center Braced Wall Line Spacing (feet)	
	Basic	Exception
B, C, D ₀ , D ₁	34	NA
D ₂ , E	25	In one- and two-story single-family dwellings, interior braced wall line spacing shall be permitted to be increased to not more than 34 feet on center in order to accommodate one single room per dwelling, not to exceed 900 square feet.

Table 8.5-2 Braced Wall Panels (Based on 1997 UBC Table 23-I-W)

Seismic Design Category	Condition	Construction Method								
		1	2	3	4	5	6	7	8	
B, C, D ₀ , D ₁	First story of 2 story		×	×	×	×	×	×	×	Each end and not more than 25 feet on center
D ₂ , E	First Story of 2 story		×	×	×	×	×	×	×	Each end and not more than 25 feet on center, but not less than 25% of buildings length

Table 8.5-3 Braced Wall Panel Construction Methods (Based on 1997 UBC Sec. 2320.11.3)

Construction Method	Description	
	Material	Construction
2	Diagonal wood sheathing	Wood boards of 5/8-inch net minimum thickness applied diagonally on studs spaced not over 24 inches on center
3	Wood structural panel sheathing	Wood structural panel sheathing with a thickness not less than 5/16-inch for 16-inch stud spacing and not less than 3/8 inch for 24-inch stud spacing in accordance with Table 3.2-1
4	Fiberboard sheathing	4-foot by 8-foot panels not less than 1/2 inch thick applied vertically on studs spaced not over 16 inches on center when installed in accordance with Table 3.2-1
5	Gypsum board sheathing	1/2-inch thick by 4 feet wide, wallboard of veneer base, on studs spaced not over 24 inches on center and nailed at 7 inches on center with nails as required by Table 3.2-1
6	Particleboard wall sheathing	Sheathing panels where installed in accordance with Table 3.2-1
7	Portland cement plaster	Portland cement plaster on studs spaced 16 inches on center, installed in accordance with Table 3.2-1
8	Hardboard panel siding	Hardboard siding installed in accordance with Table 3.2-1

Table 8.5-4 Maximum Length of Braced Wall Panels (Based on 1997 UBC Sec. 2320)

Construction Method	Minimum Length (feet)	Description
2, 3, 4, 6, 7, 8	4	NA
5	8	Applied to one face
	4	Applied to both faces

8.5.2 1997 UBC Engineered Seismic Design Provisions

Existing ground story bracing walls being checked for compliance to the 1997 UBC engineered seismic design provisions shall have an engineered vulnerability-based assessment or general engineered assessment.

8.5.3 2000 or later IRC Seismic Wall Bracing Provisions

Existing ground story bracing walls being checked for conformance to the 2000 or later IRC seismic wall bracing provisions shall have the type and extent of sheathing or bracing assessed by a registered design professional or licensed contractor.

8.5.4 2000 or later IBC Engineered Seismic Design Provisions

Existing ground story bracing walls being checked for conformance to the 2000 or later IBC engineered seismic design provisions shall have an engineered vulnerability-based assessment or general engineered assessment.

Appendix L

Summary of Loads for Simplified Engineering Retrofit

The following tables provide a detailed summary of loads used during the development of prescriptive design procedures presented in this standard. They are provided as guidance for the registered design professional where “Simplified Engineering Retrofit” is used. The registered design professional will need to verify actual roof, floor and wall assemblies and modify these loads as necessary based upon actual condition. The tables below were developed for *crawlspace dwellings*. Modifications may be appropriate for other dwelling types.

Table L-1 Suggested Roof Design Dead Loads—Gravity/Seismic Flat Weight Takeoff (psf)

Roof Light		Roof Heavy	
Material	Seismic Weight (psf)	Material	Seismic Weight (psf)
Roofing (Asphalt Shingles- max 2 layers)	4.0	Roofing *(Conc. Tiles)	11.0
Solar / other	0.0	Solar / other	0.0
Topping	0.0	Topping	0.0
1x skip sheathing + new 1/2 sheathing	2.0	1x skip sheathing + new 1/2 sheathing	2.0
Insulation	0.5	Insulation	0.5
M.E.P.	0.5	M.E.P.	0.5
Ceiling (1/2") gyp	2.5	Wood lath and 1" gypsum plaster (1 side)	8.0
Ceiling joists (2x6 @24")	1.0	Ceiling joists (2x6 @24")	1.0
Roof rafters (2x8 @24")	1.3	Roof rafters (2x8 @24")	1.3
Girders (4x8 @ 8')	0.8	Girders (4x12@ 8')	1.2
Columns	0.0	Columns	0.0
Misc.	0.4	Misc.	0.4
Dead Load	13.0	Dead Load	25.9
Roof Medium (Type 2)		Roof Medium (Type 1)	
Material	Seismic Weight (psf)	Material	Seismic Weight (psf)
Roofing *(Conc. Tiles)	11.0	Roofing (Asphalt Shingles- max 2 layers)	4.0
Solar / other	0.0	Solar / other	0.0
Topping	0.0	Topping	0.0
1x skip sheathing + new 1/2 sheathing	2.0	1x skip sheathing + new 1/2 sheathing	2.0
Insulation	0.5	Insulation	0.5
M.E.P.	0.5	M.E.P.	0.5
Ceiling (1/2") gyp	2.5	Wood lath and 1" gypsum plaster (1 side)	8.0
Ceiling joists (2x6 @24")	1.0	Ceiling joists (2x6 @24")	1.0
Roof rafters (2x8 @24")	1.3	Roof rafters (2x8 @24")	1.3
Girders (4x12@ 8')	1.2	Girders (4x8 @ 8')	0.8
Columns	0.0	Columns	0.0
Misc.	0.4	Misc.	0.4
Dead Load	20.4	Dead Load	18.5

* Use 19 psf for clay tile roofs.

Table L-2 Suggested Floor Design Dead Loads

2nd Floor - Light		2nd Floor - Heavy	
Material	Seismic Weight (psf)	Material	Seismic Weight (psf)
Floor finish* (assumes carpet and pad)	1.4	Floor finish *(assumes 7/8" hardwood)	3.6
Other	0.0	Other	0.0
Topping	0.0	Topping	0.0
Sheathing / (assume 1" horiz. Lumber)	2.3	Sheathing / (assume 1" horiz. Lumber)	2.3
Insulation	0.5	Insulation	0.5
M.E.P.	0.5	M.E.P.	0.5
1/2" Gyp. wall board	2.5	Wood Lath +1" Gypsum Plaster (1 side)	8.0
Sprinklers	0.0	Sprinklers	0.0
Joists (2x8 @ 16")	2.1	Joists (2x8 @ 16")	2.1
Girders (4x12@ 8')	1.2	Girders (4x12@ 8')	1.2
Columns	0.0	Columns	0.0
Tile	1.0	Tile	2.0
Misc.	0.5	Misc.	0.8
Dead Load	12.0	Dead Load	21.0
1st Floor (no ceiling finish at underside of floor framing)			
Material	Seismic Weight (psf)		
Floor finish**(assumes 7/8" hardwood)	3.6		
Other	0.0		
Topping	0.0		
Sheathing / (assume 1" horiz. Lumber)	2.3		
Insulation	0.5		
M.E.P.	0.5		
Ceiling (unfinished)	0.0		
Sprinklers	0.0		
Joists (2x8 @ 16")	1.9		
Girders (4x12@ 8')	1.2		
Columns	0.0		
Tile	2.0		
Misc.	0.0		
Dead Load	12.0		

* Use 6 psf for areas with tile or other heavy floor finish.

** Use 2 psf for tile (6 psf is unit weight).

Table L-3 Suggested Exterior Wall Design Dead Loads

EXTERIOR - Light (Type 1)		EXTERIOR - Medium- (Type 2)	
Material	Weight (psf)	Material	Weight (psf)
exterior paper	0.4	exterior paper	0.4
1" Lumber siding	2.3	1" Lumber siding	2.3
2x4 @ 16"oc	1.0	2x4 @ 16"oc	1.0
Insulation	0.5	Insulation	0.5
1/2" gyp. wall board (1 side)	2.5	Wood lath and 1" gypsum plaster (1 side)	8.0
Misc.	0.3	Misc.	0.8
TOTAL	7.0	TOTAL	13.0
EXTERIOR - Medium+ (Type 3)		EXTERIOR - Heavy (Type 4)	
Material	Weight (psf)	Material	Weight (psf)
Stucco (7/8" thick one side)	10.0	Stucco (7/8" thick one side)	10.0
	0.0	1" lumber siding and waterproofing	2.7
2x4 @ 16"oc	1.0	2x4 @ 16"oc	1.0
Insulation	0.5	Insulation	0.5
1/2" gyp. wall board (1 side)	2.5	Wood lath and 1" gypsum plaster (1 side)	8.0
Misc.	0.5	Misc.	0.8
TOTAL	14.5	TOTAL	23.0

Table L-4 Suggested Exterior Cripple Wall Design Dead Loads

EXTERIOR Cripple Wall – Light Retrofitted		EXTERIOR Cripple Wall – Heavy Retrofitted	
Material	Weight (psf)	Material	Weight (psf)
Waterproofing	0.4	Stucco (7/8" thick one side)	10.0
1" Lumber siding	2.3	1" lumber siding and waterproofing	2.7
2x4 @ 16"oc	1.0	2x4 @ 16"oc	1.0
1/2 in Plywood	2.0	1/2 in Plywood	2.0
Misc.	0.3	Misc.	0.3
TOTAL	6.0	TOTAL	16.0
EXTERIOR Cripple Wall - Light (As is) GABLE WALL - Light		EXTERIOR Cripple Wall - Heavy (As-Is) GABLE WALL - Heavy	
Material	Weight (psf)	Material	Weight (psf)
Waterproofing	0.4	Stucco (7/8" thick one side)	10.0
1" Lumber siding	2.3	1" lumber siding and waterproofing	2.7
2x4 @ 16"oc	1.0	2x4 @ 16"oc	1.0
Misc.	0.3	Misc.	0.3
TOTAL	4.0	TOTAL	14.0

Table L-5 Suggested Interior Wall Design Dead Loads

INTERIOR -Light		INTERIOR - Heavy	
Material	Weight (psf)	Material	Weight (psf)
1/2" gyp. wall board (2 sides)	5.0	Wood Lath and 1" Gypsum Plaster (2 sides)	16.0
2x4 @ 16"oc	1.0	2x4 @ 16"oc	1.0
Insulation	0.0	Insulation	0.0
MEP	0.5	MEP	0.4
Misc.	0.5	Misc.	0.6
TOTAL	7.0	TOTAL	18.0

Other Vulnerabilities

O.1 General

As discussed in Sections 1.7 and C1.7, this standard is vulnerability-based, focusing on assessment and retrofit of known seismic vulnerabilities judged to be of priority for improving seismic performance. There are a number of other common sources of seismic vulnerability or damage that a homeowner or resident might be interested in addressing. This section provides a partial list of other common vulnerabilities and resources for mitigation.

O.2 Other Common Vulnerabilities

The following are sources of vulnerability or damage not specifically addressed by the assessment and retrofit provisions of this standard. The items listed range in level of risk and effort and cost required to mitigate the risk.

- **Water heaters.** Water heaters are a very common source of damage, ranging from fire started by damaged gas lines, to water damage that occurs when the tank fractures. Bracing of water heaters is relatively easy and inexpensive, with premanufactured seismic strapping kits available at many local hardware stores.
- **Contents.** Furniture and other home contents can fall during an earthquake, potentially injuring occupants. Practical and inexpensive approaches are available for anchoring contents to walls and the floor. Alternatively, some contents might be moved away from commonly used areas, paths of travel, and particularly exits. Priority should be given to taller and heavier contents that provide higher seismic hazard to occupants.
- **Decks and exit porches.** Decks and porches are often only nominally fastened to the dwelling that is supporting them. Under moderate to high earthquake shaking, they can pull away and collapse. Practical methods are available to better anchor decks and porches to the dwelling, or to provide bracing between the deck or porch and the supporting foundation.
- **Roof tiles.** Clay tiles can become dislodged from roofs and pose a falling hazard, particularly when not installed and fastened per recent building

code requirements. While the short-term risk can be addressed by keeping clear of the edge of the roof, it is also possible to better anchor the roof tiles to resist falling.

- Wood burning stoves and propane tanks. When not anchored or restrained, wood burning stoves and propane tanks can shift or topple in an earthquake, causing damage and potential fire hazards.
- Overhead windows and skylights. Where large areas of glass (or mirror) occur, there is higher likelihood of breakage. Measures available to mitigate risk include applying films to glazing. Films will not reduce breakage, but could help to reduce spread of broken glass.
- Wall bracing in occupied stories. Existing walls, both interior and exterior, provide earthquake bracing to dwellings. However, the amount of bracing wall in a dwelling can vary widely. Dwellings with very low amounts of bracing wall are more susceptible to earthquake damage including cracking of finishes, permanent wall deflection, and jamming of doors. Earthquake performance can be improved by adding more walls or adding more strength and stiffness to existing walls. This is particularly easy to accomplish during remodeling. When remodeling the interior of a dwelling, it is reasonable to add wood structural panel sheathing to walls where finish materials are being removed and reinstalled. The benefit of adding wood structural panel sheathing will vary significantly based on the overall configuration of the dwelling, but will improve the seismic performance.
- Anchorage to slab-on-ground foundations. Although not seen as a significant source of damage in recent earthquakes, inadequate anchorage of wood light-frame dwellings to slab-on-ground foundation is a potential vulnerability. Typical damage modes include shifting of the dwelling walls relative to the foundation, and associated damage to the wall framing and finish materials. Addition of supplemental anchorage can mitigate this vulnerability.
- Split-level dwellings. The term split-level is used for dwellings that have vertical offsets in their framed floors. In past earthquakes separations have occurred between portions of the dwelling having different floor levels, in some cases leading to collapse of a portion of the dwelling. Mitigation for split-level dwellings involves adequate connections between portions of the dwelling to resist separation.
- Roof sheathing. Adding wood structural panel sheathing to a roof sheathed with solid or space lumber sheathing will not make the dwelling more vulnerable, and may make it marginally better. Addition of roof

wood structural panel sheathing should only occur when the roofing is to be replaced for other reasons.

O.3 Resources for Addressing Vulnerabilities

The following are recommended resources for those interested in addressing other vulnerabilities:

- FEMA P-50, *Simplified Seismic Assessment of Detached, Single-Family, Wood-Frame Dwellings* (FEMA, 2012a)
- FEMA P-50-1, *Seismic Retrofit Guidelines for Detached, Single-Family, Wood-Frame Dwellings* (FEMA, 2012b)
- FEMA E-74, *Reducing the Risks of Nonstructural Earthquake Damage* (FEMA, 2012c)
- *Homeowner's Guide to Earthquake Safety* (CSSC, 2005)
- *Guidelines for Earthquake Bracing Residential Water Heaters* (DSA, 2014)
- FEMA 528, *Earthquake Home Hazard Hunt* (FEMA, 2014a)
- FEMA P-909 CD, *Home and Business Earthquake Safety and Mitigation* (FEMA, 2014b)
- FEMA 530, *Earthquake Safety Guide for Homeowners*, currently out of print and being updated

As discussed in Section 1.9, use of this standard is permitted whether or not there is potential for or occurrence of a site soil hazard that could impact the performance of a dwelling. This is permitted because retrofit of the vulnerabilities addressed by this standard are thought to provide benefit, even if somewhat reduced by the occurrence of site soils hazards.

Although this approach has been taken by the standard, where dwellings are potentially subjected to site soil hazards, the owners should be aware and encouraged to further understand the implications of the site soil hazards for the performance of their dwelling. This appendix provides background information to assist the owner in understanding site soil hazards, and identifies resources to help the homeowner determine if such hazards potentially affect the dwelling.

S.1 Overview

When evaluating the need to improve the performance of a single-family dwelling during an earthquake, an important factor is the behavior of the ground supporting the dwelling. Location of dwelling will govern the level of shaking and the earthquake-induced potential hazards. There are two types of ground related issues: static and earthquake. Static ground-related issues are generally associated with movements of loose sand, soft clay, expansive soil (soil that expands and shrinks with moisture changes), and/or presence of ground water.

Earthquake related site factors include level of ground shaking, ground rupture, loss of foundation support and excessive ground and foundation movement. Geologic hazards, such as stability of slopes, may also be present and may impact the structural performance of the dwelling during an earthquake and warrant evaluation. To properly assess whether hazards exist may require the services of a geologist or geotechnical engineer.

S.2 Site Soil Hazard Definitions

Site soil hazards that shall be considered include: ground shaking, fault rupture, liquefaction, slope stability, densification, and differential compaction. This section provides an introduction to these hazards.

S.2.1 Ground Shaking

The intensity of ground shaking is the primary factor that affects the performance of structures during earthquakes. The level of shaking depends on the closeness to the fault; the closer to the fault, the greater the level of shaking. Geologic maps prepared by the United States Geological Survey (USGS) or by Geological Surveys of particular states, e.g., California Geological Survey (CGS), provide location of mapped faults. Fault Rupture Hazard Zone maps for California provide location of faults. Also, local jurisdictions may have maps that show faults.

USGS has prepared ground shaking maps for the United States and its territories that are part of the national building codes and standards such as the IRC, IBC, ASCE 7, and ASCE 41. These maps can be used to assess the level of shaking from earthquakes at dwelling. The knowledge of how strong the ground will shake in earthquakes will form the basis for retrofit of dwellings. As discussed in Section 1.6, ground shaking hazard is directly considered in the design of retrofits, whether by prescriptive or engineered methods.

S.2.2 Fault Rupture

Dwellings that are close to active faults may be impacted by ground rupture resulting from earthquakes. Fault Rupture Hazard Zone maps for California present areas close to the main traces of active faults where ground rupture could occur. In California, these maps are also known as Alquist-Priolo maps and can be obtained from the Public Information office of the California Geological Survey (CGS) or on the website (http://www.quake.ca.gov/gmaps/ap/ap_maps.htm). If a dwelling straddles a fault, a geologist and geotechnical engineer shall be retained to assess if a retrofit is warranted to reduce the potential for collapse as a result of fault movement.

S.2.3 Liquefaction

Liquefaction is a phenomenon where saturated, loose, sandy soil loses strength because of earthquake shaking. Once liquefaction occurs sandy soil transforms from a solid to a liquefied state. The manifestation of liquefaction is loss of foundation bearing and formation of sand boils at the surface. Consequences of liquefaction are loss of bearing, vertical settlement, and lateral movement of the ground. Depending on the severity of liquefaction, dwellings on potentially liquefiable soil can suffer significant damage or collapse.

Typical measures for mitigation against liquefaction of loose sandy soil are densification or solidification. Compaction grouting consists of pumping

low slum cement grout into the ground and displaces the soil and densifies it. Solidification is achieved by mixing the soil with cement or injecting ultra-fine cement into the soil mass.

In addition, impacts of liquefaction can be reduced by: transferring the foundation loads to competent soil below the liquefiable layers (this can be achieved by using micropiles - small diameter piles); constructing tie beams between isolated footings to form a grid system; or by, constructing a stiffened foundation mat that can withstand liquefaction-induced deformations and localized loss of foundation bearing.

For areas where lateral movement (lateral spreading) of the ground can occur, large volumes of soil shall be strengthened to create a buttress structure capable of resisting lateral movement. Mitigation against lateral spreading is difficult to achieve because the conditions associated with lateral spreading are global and not site-specific; that is, the mitigation may involve more than the single-family dwelling.

S.2.4 Slope Stability

If a dwelling is constructed on a hillside, stability of slopes during earthquake shaking is critical to its structural performance. Geologic maps that delineate slope stability hazard can be checked to evaluate the hazard at a dwelling. If slope stability hazard is present; mitigation measures that could be implemented are improving drainage and building a buttress or a wall. Less costly alternatives could include strengthening the dwelling to resist movements by construction of grade beams or shear walls.

S.2.5 Densification and Differential Compaction

Densification and differential compaction are phenomena in which non-saturated, sandy soil is compacted by earthquake vibrations. This phenomenon can cause differential settlement and may occur during strong ground shaking in loose, clean, sandy soil above the water table, resulting in ground settlement. Typically, the impact of this factor is relatively small and usually, the amount of differential compaction is on the order of a few inches or less. To improve performance, tying the foundations together is a relatively inexpensive and simple solution.

S.3 Simplified Site Assessment/Screening

For those interested in evaluating the potential for site soil hazards at a particular dwelling site, this section identifies available resources.

S.3.1 Ground Shaking

Refer to USGS website, USGS maps, geologic maps, California Fault Rupture Hazard Zone maps and/or local jurisdictions.

S.3.2 Fault Rupture

Refer to geologic fault maps, e.g., USGS, local State Geologic surveys, California Fault Rupture Hazard Zone maps and/or local jurisdictions.

S.3.3 Liquefaction

Refer to hazard maps (e.g., California), building codes, and consult with local jurisdiction. If the dwelling is in an area where the potential for liquefaction exists, local jurisdictions may mandate the need to retain the services of geotechnical engineer to quantify and evaluate the impact of liquefaction on the performance of the structure.

S.3.4 Slope Stability

Refer to geologic hazard maps published by USGS or State geological surveys and check with local jurisdiction requirements. In general, if a site is underlain by stiff soil (Site Class D) with a ground inclination of flatter than four horizontal to one vertical (4:1), stability of the slope should not be an issue. If the site inclination is steeper than 4:1, then subsurface condition and stability shall be assessed by a geologist or geotechnical engineer. Local jurisdictions/codes may require a geotechnical/geologic report as part of the assessment.

S.3.5 Densification and Differential Compaction

Hazard zone maps for the local jurisdiction should be screened. Generally, even with the presence of thick deposits of dry loose sand, densification and differential compaction are small, and therefore, typically not a factor.

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A. Before you begin:

1. This Plan Set is intended for use by a general contractor or homeowner without necessarily having to involve a Registered Design Professional.
2. Contact your local Building Official, often known as the Building Department, to understand the building permit application. Inquire about:
 - a. Fees
 - b. How many copies of the plans must be submitted
 - c. Which inspections are required
3. The Building Official may also be able to assist with assessing the applicability of this Plan Set to a home, see Eligibility For Use, Sheet S0.
4. Complete the Eligibility For Use questionnaire on Sheet S0 (Table 1), to determine if this Plan Set is applicable. A "non-complaint" answer to any question disqualifies the home from using this Plan Set, unless a Registered Design Professional is involved.

B. Determine your Seismic Design Category (SDC), Building Retrofit Configuration Type and Weight Classification

1. Refer to Sheet S3.
2. Find Seismic Design Category (SDC) which will inform what S_{DS} value to use for the dwelling.
3. Determine building retrofit/ configuration type (see descriptions and the figures on Sheet S0 for guidance).
4. After you have obtained S_{DS} and configuration type, use Figure 1 on Sheet S3 to determine which retrofit schedules are applicable to use.
5. Determine weight classification for use in the selected schedules.

C. Prepare your plans:

1. Draw a scaled plan of the perimeter of the home in the graph layout area provided on Sheet S4, Foundation and Retrofit Layout Plan. Your plan should include the following:
 - a. The location of any obstructions along the perimeter of the foundation that make the retrofitting work difficult or impossible such as fireplaces, water heaters, utilities. If the dwelling has a Ground Floor Residential Unit retrofit, this will apply to the perimeter line for the extent of the retrofit (See Figures 4 and 5 on Sheet S0). These areas should be avoided when laying out the required retrofitting work.
 - b. An arrow to indicate the direction of the span of your second floor joists above plus the spacing such as "second floor joists at 16" on center." This will be helpful when selecting the appropriate details shown on Sheets D1 - D8.1.
 - c. Dimensions for each length of perimeter wall segment and interior ground floor walls in the area of work and overall dimensions of wall lines.
 - d. An arrow pointing to North.
 - e. Label the street side (front) of the home.
 - f. See Sheet S4-ex for an example of a Plan Set submittal.
 - g. See Sheet X1 for additional example and instructions for selecting and documenting the final retrofit. Note that the example shown is for the case with a Ground Floor Residential Unit, but the same process should be applied for dwellings with a Ground Floor without Residential Unit. Review Sheet S0 for clarity on extent/ location of the of the retrofit based on your building retrofit/ configuration type (i.e. with or without a Ground Floor Residential Unit).

D. Gather information to complete the plans:

1. Review General Notes on Sheets S1 and S2 for guidance on materials and installation for the required work.
2. Review the Detail Sheets included in this Plan Set (Sheets D1 - D8.1). Locate the details that most substantially match a home's framing conditions. Not all details or Sheets will apply. As a minimum, you should have one detail each for:
 - a. The foundation sill to concrete foundation connection (Sheet D1); and
 - b. Upper floor framing to wood structural panel wall connection (Sheet D3).
3. Differences in existing conditions from those illustrated on the details that result in changes to these drawings will need to be reviewed by a Registered Design Professional. See "Purpose" on Sheet S0 for additional information.
4. Once you have selected the correct (applicable) Earthquake Retrofit Schedule Sheets (S3.1 thru S3.6), follow the Sheet instructions provided to determine the amount and type of earthquake retrofitting required along each wall line. Once Steps 1 through 7 of the Instruction Sheet are completed, document the results within the Retrofit Table as explained in Step 8.
5. Refer to Supplemental Technical Notes, on Sheet S2 where tie-downs are required.

E. Complete your plans:

1. Using information from the appropriate Earthquake Retrofit Schedule(s) Sheets S3.1 - S3.6, add the following to complete your Foundation and Retrofit Layout Plan on Sheet S4:
 - a. Indicate and dimension the total length of shear wall required at each wall line where wood structural panel retrofits occur. Also indicate any steel column or proprietary wall retrofit systems if they occur at the front or back walls.
 - b. Identify the details used for the connections as noted in D.2. Indicate the connection type and the minimum number of connectors for each wall line. Conform to Sections L and M of Sheet S1.
 - c. Identify the details used for the wood structural panel (Sheets D4 or D5).
 - d. If tie-downs are used, identify the details used (Sheet D5).
 - e. Identify the details used for the top plate splice (Sheet D6).
 - f. Identify the details used for notching and/or cutouts (Sheet D6).
 - g. If steel column retrofits are to be applied at the front or back walls, identify the details used (Sheets D7 and D7.1).
 - h. If Proprietary Shear Wall retrofits are to be applied at the front or back walls, identify the details used (Sheets D8 and D8.1).

F. Submit your plans:

1. Submit a permit application and the required number of completed sheets (Sheets S0 through D8.1) to the Building Official for review. Photographs of the foundation sill, the walls to be retrofitted, and second floor framing conditions may assist the review process.
2. Before starting work, the permit holder may be required to schedule a preconstruction inspection with the Building Official to verify that field conditions are consistent with the information provided on the approved plan.
3. Inspection(s) by the Building Official may be required for:
 - a. Foundation anchor bolts / anchor plate installation,
 - b. Blocking installation,
 - c. Wood structural panel wall; sheathing and nailing,
 - d. Steel column installation,
 - e. Proprietary Shear Wall installation,
 - f. Metal hardware "connectors" installation,
 - g. Tie-downs, and
 - h. Final inspection.

01	Instructions for Use
S0	Cover Sheet
S1	General Notes
S2	Supplemental Technical Notes Where Tie-downs are Required at Existing Foundations
S3	Earthquake Retrofit Schedule General Instructions, Weight Category, and Connectors
S3.1-1.0	Earthquake Retrofit Schedule - Wood Structural Panel with single section of wall
S3.2-1.0	Earthquake Retrofit Schedule - Wood Structural Panel with two sections of wall
S3.3-1.0	Alternate Earthquake Retrofit Schedule (Steel Column or Propriety Shear Wall)
S3.4-1.0	Earthquake Retrofit Schedule at front of garage only in dwelling with Ground Floor Residential Unit
S3.5-1.0	Earthquake Retrofit Schedule at front of garage only in dwelling with Ground Floor Residential Unit
S3.6-1.0	Alternate Earthquake Retrofit Schedule at front of garage in dwelling w/ Ground Floor Residential Unit
S4	Foundation and Retrofit Layout Plan
* S4ex	Foundation and Retrofit Layout Plan
D1	Foundation Sill to Concrete Foundation Connection Details
D2	Foundation Details at Wood Structural Panel Shear Walls
D3	Floor Framing to Wall Connection Details
D4	Wood Structural Panel Installation at Shear Walls without Tie-Downs
D5	Wood Structural Panels with Tie-Downs
D6	Vent Openings and Top Plate Details
D7	Structural Details at Steel Retrofit Column
D7.1	Foundation Details at Steel Retrofit Column
D8	Structural Details at Proprietary Shear Wall Retrofit
D8.1	Foundation Details at Proprietary Shear Wall Retrofit
* X1	Example - Living-Space-Over-Garage Dwelling with a wood structural panel shearwall & cantilever column retrofit

Note:

Retrofit schedules sheet #'s listed above (sheets S3.1-1.0 thru S3.6-1.0) are for $S_{DS} = 1.0$ only.
See Sheet S3, Figure 1 for sheet numbers for Earthquake Retrofit Schedules for $S_{DS}=1.2$ and $S_{DS}=1.5$

* Sheet for reference only. Do not submit to the Building Official.

Instructions for Use

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date:

Sheet:

01

SCOPE

This Plan Set provides prescriptive provisions for retrofit of Ground Story Bracing in Living-Space-Over-Garage Dwellings.

GENERAL

Living-Space-Over-Garage Dwellings include several types of dwellings in which living space occurs over a garage or a portion of the dwelling constructed as a garage. This term captures the dwellings in which all of the living space occurs at an upper level over a garage story, as seen in Figure 1. In this dwelling type the garage story may be unfinished and still used as a garage and utility area, or may have been partially or fully converted to a *ground story residential unit*. This term also captures dwellings where a portion of an upper level living space occurs over the garage, as seen in Figure 2.

Earthquake Retrofit Schedules in this plan set include a variety of options for retrofitting each of these configurations, including:

- Wood Structural Panel Shear Walls, with a single length of shear wall along a given wall line;
- Wood Structural Panel Shear Walls, with two sections of shear wall per wall line;
- Retrofits including Steel Columns or Proprietary Shear Walls options for front and back walls.

For Ground Story Bracing in *Living-Space-Over-Garage* Dwellings retrofit in accordance with this Plan Set, retrofit elements shall be provided as follows:

Configurations without a Ground Floor Residential Unit

- The retrofits shall include bracing elements at the dwelling front, back and side walls (See Figure 3). Bracing elements at the side walls are to be wood structural panel shear walls; bracing elements at the front and back walls are permitted to be of any of the bracing element types listed above

Configurations with a Ground Floor Residential Unit

- The retrofit shall include bracing elements at the garage front and side walls, and wall separating the garage use from the residential use (See Figures 4 and 5). Bracing elements at the front wall are permitted to be of any of the bracing element types in listed above. Bracing elements at the side walls and wall separating the garage use from the residential-use are to be wood structural panel shear walls.



Figure 1



Figure 2

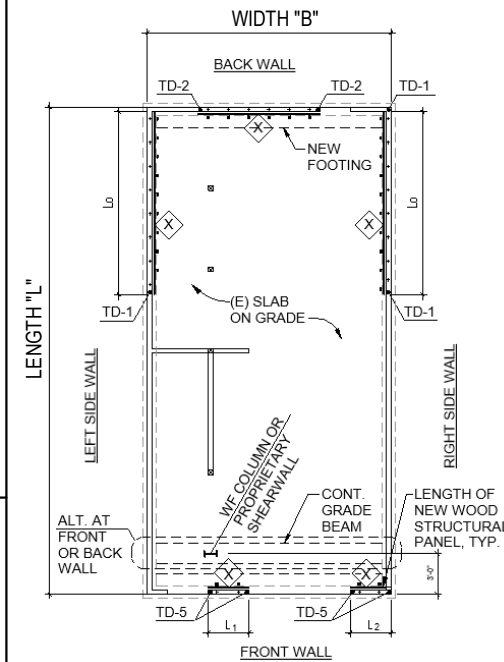


Figure 3

Example of dwelling configuration without Ground Floor Residential Unit

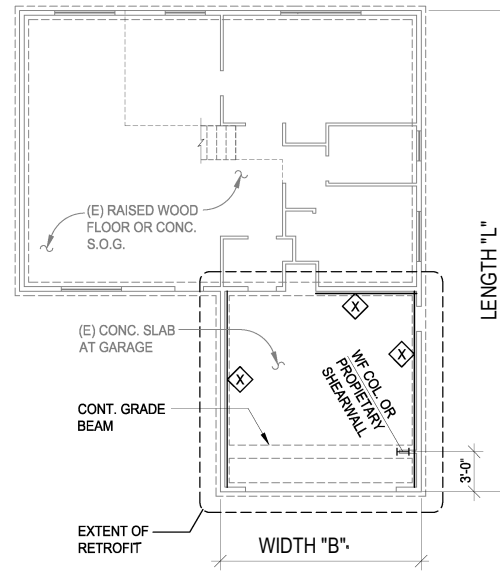


Figure 4

Example of dwelling configuration with Ground Floor Residential Unit

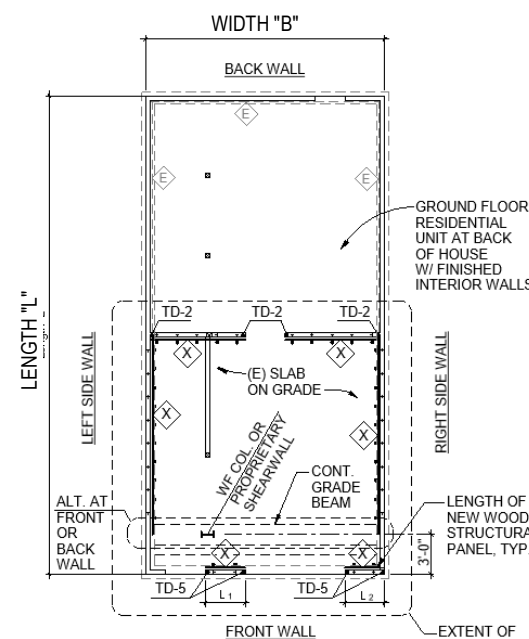


Figure 5

Example of dwelling configuration with Ground Floor Residential Unit

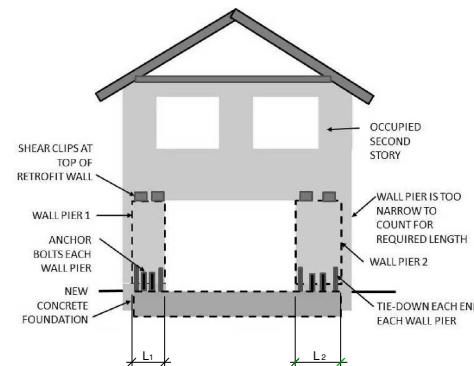


Figure 6

(2 sections of wall option shown)

TABLE 1: ELIGIBILITY FOR USE

To determine if a home qualifies, answer the following:	Compliant	Non-Compliant
1. The dwelling is a one or two-family detached structure or the dwelling is a unit in a townhouse and assessment and retrofit will occur for each attached townhouse.		
2. The dwelling is a wood light-frame dwelling and has a maximum of one story above the garage story.		
3. The dwelling is a living-space-over-garage dwelling as defined in Chapter 2		
4. The dwelling perimeter (not including porches or other appurtenances) is supported on continuous concrete foundations, concrete stem walls or thickened slab edge footings.		
5. The lower (garage) level floor is constructed of a conventionally reinforced concrete slab on grade (or at least the portion of the floor that bounds the garage).		
6. Weight of roofing material shall not exceed 12 psf (measure on slope).		
7. Weight of exterior wall finish shall not exceed 10 psf, except that veneer wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.		
8. Weight of interior wall finish shall not exceed 8 psf, except that masonry fireplace surrounds of not more than 4 inches thick and up to 100 square feet are permitted to exceed this weight.		
9. Weight of upper floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limited to 25% of the total floor area of each level.		
10. Floors in each story are at the same level and not split level, excluding slab on grade portions.		
11. The home floor area, calculated as "B" times "L", as defined in figures 3, 4 or 5 shall not exceed 2,000 square feet.		
12. No part of the foundations is constructed of unreinforced masonry or stone.		
13. Clear floor to ceiling heights at any occupied level does not exceed 9'-0".		

If you answered "Compliant" to each of these questions, proceed to Sheet S3.
If you answered "Non-compliant" to any of these questions, the home is not eligible to apply this Plan Set, unless a Registered Design Professional has addressed non-compliant issues in accordance with P-1100 Prestandard, Section 5.5. See Differing Conditions section on this sheet.

Submittal Sheet Index

- S0 Cover Sheet
- S1 General Notes
- S2 Supplemental Technical Notes Where Tie-downs are Required at Existing Foundations
- S3 Earthquake Retrofit Schedule General Instructions, Weight Category, and Connectors
- S3.1-1.0 Earthquake Retrofit Schedule - Wood Structural Panel with single section of wall
- S3.2-1.0 Earthquake Retrofit Schedule - Wood Structural Panel with two sections of wall
- S3.3-1.0 Alternate Earthquake Retrofit Schedule (Steel Column or Propriety Shear Wall)
- S3.4-1.0 Earthquake Retrofit Schedule at front of garage only in dwelling with Ground Floor Residential Unit
- S3.5-1.0 Earthquake Retrofit Schedule at front of garage only in dwelling with Ground Floor Residential Unit
- S3.6-1.0 Alternate Earthquake Retrofit Schedule at front of garage in dwelling w/ Ground Floor Residential Unit
- S4 Foundation and Retrofit Layout Plan
- D1 Foundation Sill to Concrete Foundation Connection Details
- D2 Foundation Details at Wood Structural Panel Shear Walls
- D3 Floor Framing to Wall Connection Details
- D4 Wood Structural Panel Installation at Shear Walls without Tie-Downs
- D5 Wood Structural Panels with Tie-Downs
- D6 Vent Openings and Top Plate Details
- D7 Structural Details at Steel Retrofit Column
- D7.1 Foundation Details at Steel Retrofit Column
- D8 Structural Details at Proprietary Shear Wall Retrofit
- D8.1 Foundation Details at Proprietary Shear Wall Retrofit

(*) Retrofit schedules sheet #'s listed above (sheets S3.1-1.0 thru S3.6-1.0) are for $S_{DS} = 1.0$ only. See sheet S3, Figure 1 for sheet numbers for Earthquake Retrofit Schedules for $S_{DS}=1.2$ and $S_{DS}=1.5$

APPLICANT INFORMATION

APPLICANT: _____
ADDRESS: _____
PHONE: _____
SIGNATURE: _____

Cover Sheet

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

SO

A. CODE

- All work not otherwise specified shall conform to the locally adopted version of the building code or residential code. Contractor shall comply with all locally adopted building codes and ordinances.

B. GENERAL

- The contractor is responsible for maintaining a safe job site and complying with relevant state and/or federal OSHA standards. Contractor is responsible for the means and methods for accomplishing the work shown in this Plan Set, including any shoring and bracing of existing construction as required to safely install new work. Exercise caution working around existing utilities, locate underground utilities before excavating, and arrange for temporary disconnection of utilities if necessary.

C. EXISTING CONDITIONS

- Contractor shall confirm that existing conditions match plans and details prior to start of work. Modify choice of detail as required prior to start of work.
- Contractor shall verify that existing concrete, anchor bolts, wood framing, and other materials that will become part of the work or to which retrofit construction is attached is in reasonably sound condition and free of defects that would substantially reduce the capacity of the material. Where possible, damaged or deteriorated elements shall be repaired in place or supplemented with new elements. Otherwise damaged or deteriorated members shall be replaced. Repair or replacement shall be in accordance with the adopted building or residential code.
- The Owner or Contractor shall verify that the existing concrete within all areas to receive new anchor bolts is in reasonably good condition. Examples of poor concrete quality would include excessive spalling, large rock pockets, cracks extending completely through the footing greater than 1/4" wide, or low strength concrete cement or mortar easily scrapable with a metal knife or trowel. Strengthening should be avoided in local areas of poor quality. Where these areas cannot be avoided, or where locations of poor quality are widespread, the new anchors are to be tested in accordance w/ Table C-1. Where torque tests continue to fail, the existing foundation system shall be replaced locally for a minimum of 30 inches on each side of the proposed anchor location.

Diameter Ø	Screw Anchor		Adhesive Anchor	
	Torque (ft-lbs)		Torque (ft-lbs)	
1/2"	35		15	
5/8"	50		20	

D. NOTCHING, BORING AND CUTTING

- Do not cut, bore or notch structural members except as shown in these drawings or as specifically permitted by the building inspector. Exception: Notching and boring of framing shall be permitted as per Chapter 6 of the International Residential Code (IRC).
- When drilling in concrete, do not drill through existing reinforcing steel. If reinforcing steel is hit during drilling, move a minimum of one inch and drill relocated hole. Fill original hole with non-shrink grout.

E. CONCRETE

- Concrete shall have a strength of not less than 3000 psi at 28 days (design based upon 2500 psi). Concrete mixed on site shall be mixed and placed in accordance with the manufacturer's instructions using potable water.

F. REINFORCING STEEL (REBAR)

- Reinforcing steel shall confirm to ASTM A615 Grade 40 or 60, ASTM A706, or ASTM A996 Type R.
- Reinforcing steel bend radii and other rebar detailing shall be in accordance with Concrete Reinforcing Steel Institute.
- Minimum concrete cover over reinforcing steel:

a. Concrete cast against and permanently exposed to soil:	3 inches	
b. Formed concrete exposed to weather:	2 inches	
c. Concrete not exposed to weather or in contact with soil:	1-1/2 inch	
d. Reinforcing steel lap splice lengths:	<u>No. 4</u>	<u>No. 5</u>
• Horizontal bars with more than 12 inches concrete below:	32 inches	42 inches
• Other bars:	24 inches	32 inches

G. STRUCTURAL STEEL

- Structural steel W-sections, plate, bar and miscellaneous steel shall be ASTM A992 or A572. Welding shall comply with AWS D1.1 requirements using prequalified welding procedures. All welding shall be conducted by welders certified for the materials and welding procedures used.
- Bolts shall conform to ASTM A-307. Threaded rods shall conform to ASTM A-36.

H. FASTENERS

- General
 - All bolts, nails and other fasteners in contact with preservative treated wood or exposed to weather shall be hot dip galvanized or stainless steel.
- Nails
 - Unless otherwise noted, all nails specified are to be common nails.
 - Special care is required when installing nails in existing framing. Where required to avoid splitting of framing, predrill to 75% of nail shank diameter.
 - Fasteners for wood structural panel sheathing shall be full length 8d common nails (0.131" x 2.1/2"). Drive sheathing nail head flush with face of sheathing.
 - Do not overdrive, countersink, or otherwise damage the outermost ply when installing nails. A nail is over-driven when it breaks the surface ply. Where nails are overdriven to the point that the plywood veneer is fractured, add one new nail for every (2) overdriven nails. Space new nails between existing.

3. Anchor Bolts

- Predrill bolt holes to not more than 1/16th inch larger than bolt or anchor bolt to be placed.
- At each perimeter wall line, provide a minimum quantity of Foundation Sill Anchors as required by the Earthquake Retrofit Schedule. Place new anchors between 8 and 12 inches from the end of each foundation sill plate and distribute the remaining anchors as evenly as practical along the wall line.
- Provide steel plate washers 0.229 x 3 x 3 inch minimum at all anchor bolts. Centerline of washer should be 1-1/2" to 2" from face of sheathing.
- Anchor bolts shall be a maximum spacing of 48" on center for the entire portion of all exterior walls, except as noted in Section J.
- For braced wall sections without tie-downs, provide one of the required anchor bolts within 8" of each end and one additional anchor bolt at each end as noted on Sheet D4.
- For braced wall sections with tie-downs, provide one additional anchor bolt within 8" minimum and 12" maximum from tie-down as noted on Sheet D5.

I. WOOD STRUCTURAL PANEL SHEATHING

- Wood structural panels shall be 15/32" plywood sheathing, all veneer, conforming to US voluntary Product Standard PS-1, Exposure I or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
- Oriented Strand Board (OSB) shall be 15/32" thick and conform to US Voluntary Product Standard PS 2 with an exposure rating of Exposure 1 or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
- Provide 1/8-inch minimum gap at all sheathing panel ends and edges.
- Maintain a minimum edge distance of 3/8" from center of nail to edges of sheathing, studs, or top and sill plates. See Sheet D4 for double stud at sheathing panel joints.

J. WOOD FRAMING

- Framing shall be Douglas Fir-Larch, or an approved species having a greater or equal specific gravity.
- Framing in contact with foundations or exposed to weather shall be preservative treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B). Field treat all cuts, bores and notches per AWPA M-4.

K. CONNECTOR DEVICES

- Connectors shall be pre-engineered pre-manufactured devices, approved by the Building Official and installed in accordance with the manufacturer's instructions.
- Connectors protected from weather shall be provided with a minimum of G90 zinc coating in accordance with ASTM A653. Connectors exposed to weather or in contact with preservative treated wood shall be provided with a minimum hot-dip galvanized coating or G185 coating in accordance with ASTM A653, and fasteners shall conform to ASTM A153.
- Connector devices shall be of the type and size specified in these drawings.
- Connectors required by the Earthquake Retrofit Schedule shall be distributed equally along the length of each wall line or within the length of the braced wall panel.
- Connector spacing shall not be less than 8" on center.
- Increase nail or screw length 1/2-inch minimum when installing connectors over wood structural panels.

L. POST-INSTALLED ANCHORS

- Post-installed anchors shall be installed in accordance with the manufacturer's installation instructions.
- Adhesive anchors shall be [REDACTED]
- Concrete screws shall be [REDACTED]
- See H.3 for additional anchor bolt requirements.

M. PROPRIETARY SHEAR WALLS

- Proprietary shear walls shall be prefabricated wood shear panels or prefabricated cold-formed steel shear panels [REDACTED] [REDACTED] shall have been tested in accordance with ASTM D7989, in a manner and with documentation acceptable to the building official.
- Proprietary Shear Walls shall be installed in accordance with the manufacturer's installation requirements and the provisions of this Plan Set.

N. PERMITS

- All work required by this Plan Set shall be permitted through the building department.

O. INSPECTIONS

- Contractor shall coordinate with the building inspector to ensure that work is accessible for Building Department inspections, and shall correct non-compliant work as identified by the inspector.

P. SPECIAL INSPECTIONS

- Special inspection by a third party inspector approved by the Building Official shall be provided for the following:
 - Welding of structural steel
- Special inspection by a third party inspector is not required for the following:
 - Concrete or reinforcing steel for foundations. Design is based on an ultimate concrete strength of 2500 psi or less.
 - Installation of cast-in-place or post-installed anchor bolts.
 - Installation of adhesive anchors for tie-down devices, provided that each anchor is torque-tested in accordance with Table R-2, Sheet S2.
 - Nailing of wood structural panel shear walls, provided a building department inspection is performed.

APPLICANT: _____
 PROPERTY ADDRESS: _____

General Notes

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet:

Q. PURPOSE OF SUPPLEMENTAL TECHNICAL NOTES

1. These Supplemental Technical Notes provide guidance for the installation of wood structural panel shear walls that use tie-downs at existing foundation systems. Tie-downs shall be used where specified in the Earthquake Retrofit Schedules.
2. Where "New Fdn Req'd?" response is NO but a "Tie-down" TD1 is listed in the Earthquake Retrofit Schedules - Wood Structural Panel Shear Walls sheets, additional visual verification and testing of the existing foundation system is required to be completed by the owner or general contractor and approved by the Building Official, and documented in Table R-1 prior to commencing any work. Visual verification and testing shall be as noted in Section R.
3. Where these requirements are not met, a new foundation system will be required in accordance with Sheet D2.

R. EXISTING FOUNDATION REQUIREMENTS AND TESTING

1. The size of existing foundation systems at the location of new tie-down anchors shall be verified to be at least 15" deep ("D") and 8" wide ("W"). The dimension "D" shall be measured from the bottom of footing to the underside of the existing mudsill. The dimension "W" shall be measured from the top outside face of footing to the inside top face of footing. See Table R-1, item A.1.
2. Verification of the overall quality of concrete along any wall line requiring tie-downs shall be made and documented within Table R-1, item B.1. This verification shall be made by use of a minimum of two sacrificial torque tests along each wall line where tie-downs are used. These tests shall consist of installing 1/2" or 5/8" diameter screw-type bolts into the existing concrete and verifying that a value per Table R-2 can be achieved. Torque tests can be performed either by the owner, a general contractor, or a special inspection company or testing agency hired by the owner and as approved by the Building Official.
3. Where "Tie-downs" are used to determine the sheathed panel length required along a wall line, each adhesive anchor shall be torque tested in accordance with Table R-2.

S. TIE-DOWN REQUIREMENTS

1. Tie-downs shall be _____ or an equivalent with an allowable tensile load of 3075 lbs or more, installed per manufacturer's instructions.
2. End studs(s) to which tie-downs are installed, shall be 3x minimum or double 2x. For nailing at double studs, see Sheet D4.
3. All tie-downs shall use 5/8"Ø (A36) threaded rod adhesive-type anchors with minimum embedment per Detail 1, Sheet D5.

T. MINIMUM INSTALLATION REQUIREMENTS FOR TIE-DOWN ANCHORS

1. All holes shall be drilled to the specified diameter and depth.
2. All holes shall be blown clean of dust with oil-free compressed air for a minimum of 4 seconds.
3. All holes shall be cleaned with a nylon brush for a minimum of 4 cycles.
4. Blow holes clean of dust with oil-free compressed air for a minimum of 4 seconds.
5. Check adhesive cartridge expiration date, open and install per the manufacturer's instructions.
6. Fill the holes 1/2 to 2/3 full, starting at the bottom of the hole to prevent air pockets and withdraw the nozzle as the hole fills up.
7. Insert a clean and oil-free anchor turning slowly until the anchor contacts the bottom of the hole.
8. Do not disturb the anchor until fully cured. See manufacturer's instructions.

Table R-1: Verification of Existing Foundation System

Requirement	Yes or N/A	Signature of Owner or Contractor (Owner performing work)
A.1 The size of the existing foundation is greater than or equal to that specified in Section R, item 1.		_____ Signature
B.1 The existing foundation has generally been verified to be in good condition at planned tie-down locations as specified in Section R, item 2.		_____ Signature
C.1 The capacity of each new tie-down anchor has been verified by passing the torque tests specified in Table R2.		_____ Signature
D.1 All adhesive anchors were installed per the manufacturer's instructions per the minimum steps as noted in Section T.		_____ Signature

Table R-2: Foundation Verification Requirements

	Screw Anchor	Adhesive Anchor
Diameter Ø	Torque (ft-lbs)	Torque (ft-lbs)
1/2"	35	15
5/8"	50	20

APPLICANT: _____

PROPERTY ADDRESS: _____

Supplemental Technical Notes Where Tie-downs are Required at Existing Foundations

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

Seismic Design Category (SDC) and Building Retrofit/ Configuration Type

- The first two factors taken into consideration for determining the appropriate amount of Earthquake Strengthening:
 - Site seismicity or S_{DS} value
 - Building retrofit/ configuration type
- To find appropriate S_{DS} value, which is either 1.0, 1.2, or 1.5, you must first determine your Seismic Design Category (SDC) by clicking the link below.
 - In your internet browser
 - Click on one of the five (5) geographic areas listed to find your location on the appropriate map.
 - Locate your SDC (SDC A-SDC E) by the color contour shown on the map which corresponds to the % g values shown.
 - For SDC A-D₁, use $S_{DS} = 1.0$.
 - For SDC D₂, use $S_{DS} = 1.2$ unless the site class can be determined as A, B, or D, in which case use $S_{DS} = 1.0$.
 - For SDC E, use $S_{DS} = 1.5$

Note: where your location is on, or close to, the border of two SDC's, it is prudent to choose the higher value.
- Determine building retrofit/configuration type: Does the dwelling have a ground floor residential unit? See Figures 3 thru 5 on Sheet S0 for guidance.
- Find the corresponding S_{DS} value and building retrofit/configuration type in Figure 1. You will use one or more of the Earthquake Retrofit Schedules identified in Figure 1. Do not submit any of the unused sheets to the Building Official.

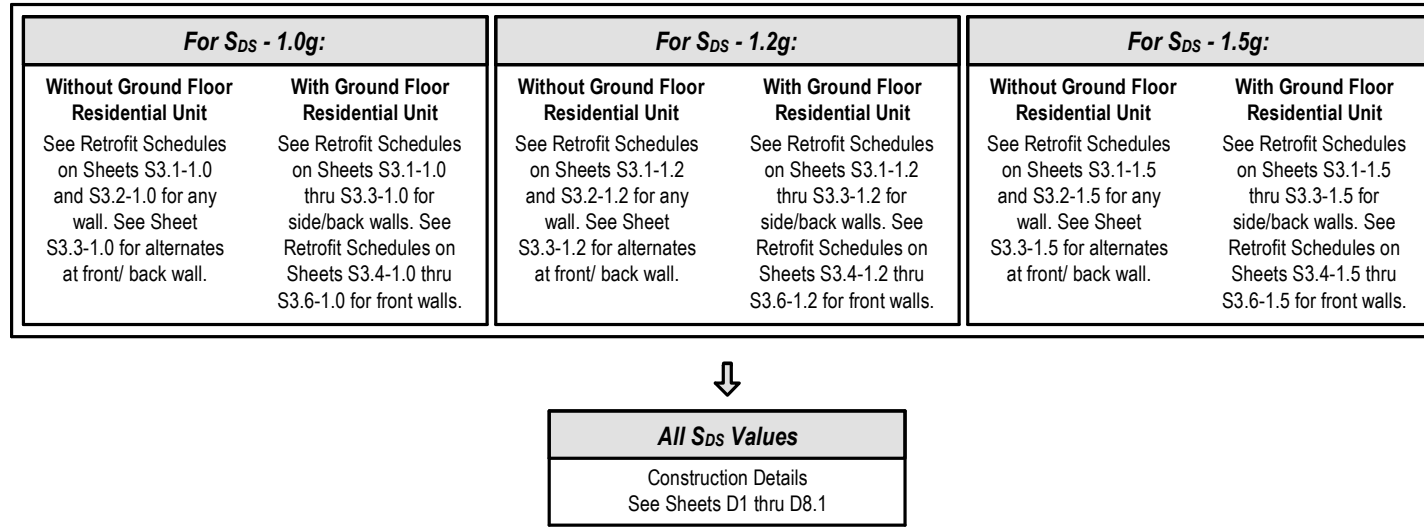
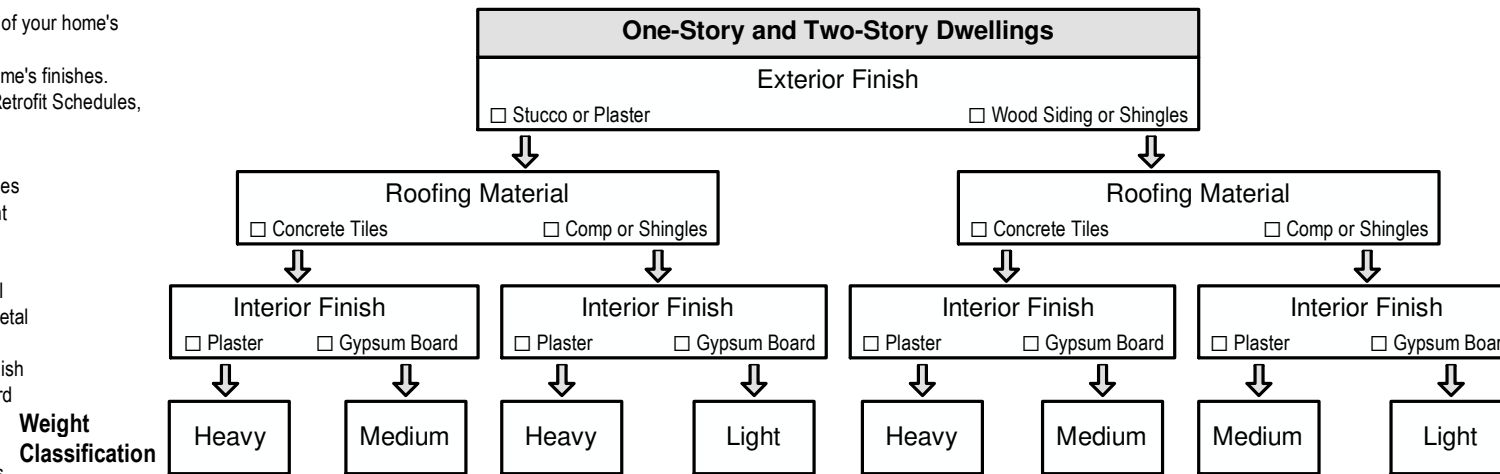


Figure 1. Earthquake Retrofit Schedules per S_{DS}

Weight Classification

- This flowchart is used to determine the general weight classification of your home's construction.
- Check the box of the material that most closely matches your home's finishes.
 - Note the Weight Classification result for use in the Earthquake Retrofit Schedules, Sheets S3.1-S3.6.
- Specific notes for exterior, interior and roof coverings:
- The "wood siding or shingles" exterior finish category also includes finishes of similar weight, including but not limited to fiber-cement and aluminum siding.
 - The "comp or shingles" roofing material category also includes roofing materials of similar weight, including but not limited to roll roofing, built-up felt roofing, single-ply membrane roofing, and metal roofing.
 - The "gypsum board" interior finish category also includes wall finish materials of similar weight, including but not limited to wood board or panel siding.
 - The exterior finish, roofing material and interior finish categories are intended to be identified based on the predominant materials used in construction. Where interior or exterior finishes vary, a heavier type finish shall be assumed where 25% or more of that heavier finish type exists within the dwelling.



Connectors

- Verify and follow manufacturer's written instructions.
- Connector images are general in nature only. Individual manufacturer's connectors may vary.
- Any of the connectors listed within a particular group (e.g. Type B) may be used for strengthening the particular condition.
- This Plan Set was developed using the listed capacity.
- Where connectors listed within the applicable Earthquake Retrofit Schedule will not fit within a particular wall line due to limitations in length, alternate connections may be substituted but shall be designed and selected by a Registered Design Professional and approved by the Building Official.

ANCHOR BOLTS

MANUFACTURER	MODEL	EMBEDMENT DEPTH	
		1/2" ϕ	5/8" ϕ
SCREW-TYPE		3-1/2"	3-1/2"
		4-1/2"	n/a
		3-3/8"	3-3/8"
ADHESIVE	Threaded Rod with:	4-1/4"	5"
		2-3/4"	3-1/8"
		2-3/4"	3-1/8"

CONNECTORS

IMAGE		CAPACITY (lbs)
	TYPE A	1530
	TYPE B	960
	TYPE C	875
	TYPE D	565
	TYPE E	740
	TYPE F	590
	TYPE G	445
	TYPE S1	725
	TYPE S2	2050

TIE-DOWNS

(Supplemental Technical Notes, Sheet S2, Section S)

MARK (kips)	IMAGE	CAPACITY (lbs)
TD1		3075
TD2		4565
TD3		5645
TD4		7870
TD5		11,175

Note: Tie-down capacities listed above are ASD and based on manufacturer's data. Where tie-down TD1 is used at existing foundations, the allowable ASD capacity used for development of this Plan Set has been reduced to 3000# and TD1 must be installed per Detail 1, Sheet D5.

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule General Instructions, Weight Category, and Connectors

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet:

S3

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.0$) for Single Section of Wall

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	④ MINIMUM REQUIRED LENGTH OF A SINGLE SECTION OF WALL OF WOOD STRUCTURAL PANEL SHEAR WALLS (at each wall line)											⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION		
			No Tie-down			w/ Tie-downs in Existing or New Foundations								Min. No. of Foundation Connectors or Anchors at Each Wall Panel					Min. No. of Connectors at Each Wall Panel		
						8d at 6" O.C.				8d at 4" O.C.											
			8d Nail Spacing	Wall Length	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
Light Construction	800		6	16'-6"	12'-6"	TD1	No	8'-6"	TD2	Yes	5'-0"	TD5	Yes	4	6	7	6	4	9	9	11
	1000		6	19'-6"	15'-6"	TD1	No	10'-6"	TD2	Yes	6'-6"	TD5	Yes	4	7	9	7	5	11	11	14
	1200		6	22'-0"	18'-6"	TD1	No	13'-0"	TD2	Yes	7'-6"	TD4	Yes	5	8	11	9	6	13	13	17
	1500		6	25'-6"	23'-6"	TD1	No	16'-0"	TD2	Yes	9'-6"	TD4	Yes	6	10	13	11	8	17	16	21
	2000		4	31'-0"	31'-0"	None	No	21'-6"	TD2	Yes	12'-6"	TD4	Yes	8	13	17	14	10	22	21	28
Medium Construction	800		6	20'-6"	16'-0"	TD1	No	11'-0"	TD2	Yes	6'-6"	TD5	Yes	5	7	9	8	5	12	11	15
	1000		6	23'-6"	20'-0"	TD1	No	14'-0"	TD2	Yes	8'-0"	TD5	Yes	6	9	11	9	7	14	14	18
	1200		6	26'-6"	24'-0"	TD1	No	16'-6"	TD2	Yes	10'-0"	TD4	Yes	7	10	14	11	8	17	17	22
	1500		6	31'-0"	30'-6"	TD1	No	20'-6"	TD2	Yes	12'-6"	TD4	Yes	8	13	17	14	10	21	21	27
	2000		4	37'-6"	40'-6"	None	No	27'-6"	TD2	Yes	16'-6"	TD4	Yes	11	17	22	18	13	28	27	36
Heavy Construction	800		6	21'-6"	21'-0"	TD1	No	14'-6"	TD2	Yes	8'-6"	TD4	Yes	6	9	12	10	7	15	14	19
	1000		4	24'-6"	26'-6"	None	No	18'-0"	TD2	Yes	10'-6"	TD4	Yes	7	11	15	12	8	19	18	24
	1200		4	27'-6"	31'-6"	None	No	21'-6"	TD1	No	13'-0"	TD4	Yes	9	13	18	15	10	22	21	28
	1500		4	29'-6"	39'-6"	None	No	27'-0"	TD1	No	16'-0"	TD4	Yes	11	17	22	18	12	28	27	35
	2000		2	30'-0"	53'-0"	None	No	36'-0"	None	No	21'-6"	TD3	Yes	14	22	29	24	16	37	35	47

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.

a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- ④ Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- ⑤ Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- ⑥ Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑦ Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- ⑧ Include Earthquake Retrofit Schedule Sheets S3.1-1.0 thru S3.6-1.0 where applicable. See sheet S3, Figure 2 and schedule notes 6 thru 8.

Notes:

1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
3. Foundations: Where new foundations are required at front and back walls, see Sheet D2 for details. At side walls, select retrofit options that do not require new foundations whenever possible. Otherwise, provide foundations that extend the full depth of the garage in Figures 4 and 5 on Sheet S0 and for Figure 3 conditions (*living-space-over-garage* dwellings without *ground floor residential unit*), consult a Registered Design Professional for remedial direction.
4. Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
5. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
6. This Plan Set was developed using the _____ listed _____ capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
7. Wall lengths are total length of a single wall section required on each side of the building. See Sheet S3.2-1.0 for 2 section of wall options.
8. See Sheet S3.3-1.0 for Alternate Earthquake Retrofit Options where sufficient length of wall does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.
9. See Sheets S3.4-1.0 thru S3.6-1.0 for Earthquake Retrofit Schedules for the front wall only at dwellings with a ground story residential unit. See also Sheet S0, Figure 2.

⑦ RETROFIT SUMMARY BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Retrofit requirements per wall line: (check box if tie-down and/or new footing will be used on that line)

<input type="checkbox"/> Front Wall _____ ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
<input type="checkbox"/> Back Wall _____ ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
<input type="checkbox"/> Left Side Walls _____ ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
<input type="checkbox"/> Right Side Walls _____ ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
2. New Foundation Sill Anchorage to be used: (check all that apply)

Bolts: Diameter _____	<input type="checkbox"/> Adhesive	<input type="checkbox"/> Screw
<input type="checkbox"/> Type "A" Connector	<input type="checkbox"/> Type "C" Connector	
<input type="checkbox"/> Type "B" Connector		

 Minimum required number of Sill Anchors per wall line _____
3. Floor Framing Connectors (to Top Plate) to be used: (check all that apply)

<input type="checkbox"/> Type "D"	<input type="checkbox"/> Type "F"
<input type="checkbox"/> Type "E"	<input type="checkbox"/> Type "G"

 Minimum required number of Floor Framing Connectors per wall line _____
4. Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.

<input type="checkbox"/> S3.2-1.0	<input type="checkbox"/> S3.4-1.0	<input type="checkbox"/> S3.6-1.0
<input type="checkbox"/> S3.3-1.0	<input type="checkbox"/> S3.5-1.0	

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - Wood Structural Panel with
single section of wall
Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family
Dwellings

Date: _____

Sheet: _____

S3.1-1.0

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.0$) Two Sections of Wall

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	④ MINIMUM TOTAL REQUIRED LENGTH OF EACH SECTION OF WOOD STRUCTURAL PANEL SHEAR WALL For a Two Section of Wall Option						⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION		
			Length per Section for a Two Section Option						Min. No. of Foundation Connectors or Anchors at Each Section of Wall					Min. No. of Connectors at Each Section of Wall		
			8d at 6" O.C.			8d at 2" O.C.			Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
			Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?								
Light Construction	800		6'-6"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	5	6
	1000		8'-0"	TD1	No	3'-6"	TD4	Yes	2	4	5	4	3	6	6	7
	1200		9'-6"	TD1	No	4'-0"	TD4	Yes	3	4	6	5	3	7	7	9
	1500		12'-0"	TD1	No	5'-0"	TD4	Yes	3	5	7	6	4	9	8	11
	2000		15'-6"	None	No	6'-6"	TD4	Yes	4	7	9	7	5	11	11	14
Medium Construction	800		8'-0"	TD1	No	3'-6"	TD5	Yes	3	4	5	4	3	6	6	8
	1000		10'-0"	TD1	No	4'-0"	TD5	Yes	3	5	6	5	4	7	7	9
	1200		12'-0"	TD1	No	5'-0"	TD5	Yes	4	5	7	6	4	9	9	11
	1500		15'-0"	TD1	No	6'-0"	TD4	Yes	4	7	9	7	5	11	11	14
	2000		20'-0"	None	No	8'-6"	TD4	Yes	6	9	11	9	7	14	14	18
Heavy Construction	800		10'-6"	TD1	No	4'-6"	TD4	Yes	3	5	6	5	4	8	7	10
	1000		13'-0"	None	No	5'-6"	TD4	Yes	4	6	8	6	4	10	9	12
	1200		16'-0"	None	No	6'-6"	TD4	Yes	5	7	9	8	5	11	11	14
	1500		20'-0"	None	No	8'-0"	TD4	Yes	6	9	11	9	6	14	14	18
	2000		26'-6"	None	No	11'-0"	TD3	Yes	7	11	15	12	8	19	18	24

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per section of wall, placed within the length of strengthening where possible. Total number of anchor bolts and connectors shall equal twice the number shown in the schedule. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
- Foundations: Where new foundations are required at front and back walls, see Sheet D2 for details. At side walls, select retrofit options that do not require new foundations whenever possible. Otherwise, provide foundations that extend the full depth of the garage in Figures 4 and 5 on Sheet S0 and for Figure 3 conditions (*living-space-over-garage dwellings without ground floor residential unit*), consult a Registered Design Professional for remedial direction.
- Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the ██████████ listed ██████████ capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Wall lengths are total length of wall required on each side of the building. You may use 2 sections of wall per line based on existing building conditions but each section must be at least 3 feet long and each individual section shall not be greater than 55% of the total require length. (See Figure D-6 on Sheets S0).
- See Sheet S3.3-1.0 for Alternate Earthquake Retrofit Options where sufficient length of wall panel does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.
- See Sheets S3.4-1.0 thru S3.6-1.0 for Earthquake Retrofit Schedules for the front wall only at dwellings with a ground story residential unit. See also Sheet S0, Figure 2.

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - Approximate floor area _____
- Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- Include Earthquake Retrofit Schedule Sheets S3.1-1.0 thru S3.6-1.0 where applicable. See sheet S3, Figure 2 and schedule notes 6 thru 8.

⑦ RETROFIT SUMMARY BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

- Retrofit requirements at each section of wall, per wall line: (check box if tie-down and/or new footing will be used on that line)

<input type="checkbox"/> Front Wall _____ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
<input type="checkbox"/> Back Wall _____ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
<input type="checkbox"/> Left Side Walls _____ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
<input type="checkbox"/> Right Side Walls _____ft	<input type="checkbox"/> Nailing: 8d at ____ O.C.	<input type="checkbox"/> Tie-Down Type _____	<input type="checkbox"/> New Ftg
- New Foundation Sill Anchorage to be used: (check all that apply)

Bolts: Diameter _____	<input type="checkbox"/> Adhesive	<input type="checkbox"/> Screw
<input type="checkbox"/> Type "A" Connector	<input type="checkbox"/> Type "C" Connector	
<input type="checkbox"/> Type "B" Connector		
Minimum required number of Sill Anchors at each section of wall, per wall line _____		
- Floor Framing Connectors (to Top Plate) to be used: (check all that apply)

<input type="checkbox"/> Type "D"	<input type="checkbox"/> Type "F"
<input type="checkbox"/> Type "E"	<input type="checkbox"/> Type "G"
Minimum required number of Floor Framing Connectors at each section of wall, per wall line _____	
- Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

- Check if this Sheet is supplemental to sheet S3.1, otherwise check if additional retrofit schedule are required.

<input type="checkbox"/> S3.2-1.0	<input type="checkbox"/> S3.4-1.0	<input type="checkbox"/> S3.6-1.0
<input type="checkbox"/> S3.3-1.0	<input type="checkbox"/> S3.5-1.0	

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - Wood Structural Panel with two sections of wall

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.2-1.0

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.0$)						
① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	④ STEEL COLUMN RETROFIT (2) (3)		⑤ PROPRIETARY SHEAR WALL RETROFIT (4) (5)	⑥ DIAPHRAGM NAILING (3) (5)
			Steel Column	Column Connection Type (per detail 2 on sheet D7) at Upper Floor	Minimum Required at Allowable Shear Capacity (Pounds)	Edge Nail Spacing
Light Construction	800		W8x21	C1	3250	6
	1000		W8x21	C1	4060	6
	1200		W8x28	C1	4870	6
	1500		W8x28	C1	6090	6
	2000		W10x30	C2	8120	6
Medium Construction	800		W8x21	C1	4200	6
	1000		W8x28	C1	5250	6
	1200		W8x28	C1	6300	6
	1500		W10x30	C2	7880	6
	2000		W12x35	C3	10,500	6
Heavy Construction	800		W8x28	C1	5400	6
	1000		W8x28	C1	6860	4
	1200		W10x30	C2	8230	4
	1500		W12x35	C3	10,300	4
	2000		W10x45	C3	13,700	4

Notes:

1. Steel column and Proprietary Shear Wall Options are provided for front of garage or back of garage or house only.
2. See detail 4 on Sheet D7 for footing detail at steel column retrofit.
3. See details 1 & 2 on Sheet D7 for steel column connections at upper floor.
4. See details 4 & 5 on Sheet D8 for footing details at proprietary shear wall.
5. See details 1 & 2 on Sheet D8 for upper floor connection at proprietary shear wall.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to select the steel column size and connection type or proprietary shear wall required.
- ④ Determine size of steel column and connection detail or see ⑤.
- ⑤ Determine minimum required allowable shear capacity to be used in selection of a proprietary shear wall. Note that more than one shear wall panel may be needed to obtain the required shear capacity. Consult manufacturer's load tables for final selection.
- ⑥ See details 1 & 2 on sheet D7 for steel column connections at upper floor. See details 1 & 2 on sheet D8 for upper floor connection at proprietary shear wall.
- ⑦ Complete retrofit summary below.

⑦ RETROFIT SUMMARY
check box if selected

Steel Column

At front wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

At back wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

Proprietary Shear Wall

At front wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

At back wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.
- S3.1-1.0 S3.3-1.0 S3.5-1.0
 S3.2-1.0 S3.4-1.0

APPLICANT: _____
 PROPERTY ADDRESS: _____

Alternate Earthquake Retrofit Schedule (Steel Column or Proprietary Shear Wall)

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
 Sheet: _____

S3.3-1.0

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.0) for Single Section of Wall at Front of Garage - Only

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	④ MINIMUM REQUIRED LENGTH OF A SINGLE SECTION OF WALL OF WOOD STRUCTURAL PANEL SHEAR WALLS (at each wall line)											⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION		
			No Tie-down			w/ Tie-downs in Existing or New Foundations								Min. No. of Foundation Connectors or Anchors at Each Wall Panel					Min. No. of Connectors at Each Wall Panel		
						8d at 6" O.C.			8d at 4" O.C.			8d at 2" O.C.									
			8d Nail Spacing	Wall Length	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
Light Construction	800		6	10'-0"	6'-0"	TD2	Yes	4'-6"	TD3	Yes	3'-0"	TD4	Yes	2	3	4	3	2	5	5	6
	1000		6	11'-6"	8'-0"	TD1	No	5'-6"	TD3	Yes	3'-6"	TD5	Yes	2	4	5	4	3	6	6	7
	1200		6	13'-6"	9'-6"	TD1	No	6'-6"	TD2	Yes	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9
	1500		6	15'-6"	11'-6"	TD1	No	8'-0"	TD2	Yes	5'-0"	TD5	Yes	3	5	7	6	4	9	8	11
	2000		6	19'-6"	15'-6"	TD1	No	10'-6"	TD2	Yes	6'-6"	TD5	Yes	4	7	9	7	5	11	11	14
Medium Construction	800		6	12'-6"	8'-0"	TD1	No	5'-6"	TD3	Yes	3'-6"	TD5	Yes	3	4	5	4	3	6	6	8
	1000		6	14'-6"	10'-0"	TD1	No	7'-0"	TD3	Yes	4'-0"	TD5	Yes	3	5	6	5	4	7	7	9
	1200		6	16'-6"	12'-0"	TD1	No	8'-6"	TD2	Yes	5'-0"	TD5	Yes	4	5	7	6	4	9	9	11
	1500		6	19'-6"	15'-0"	TD1	No	10'-6"	TD2	Yes	6'-0"	TD5	Yes	4	7	9	7	5	11	11	14
	2000		6	24'-0"	20'-0"	TD1	No	14'-0"	TD2	Yes	8'-0"	TD5	Yes	6	9	11	9	7	14	14	18
Heavy Construction	800		6	13'-6"	10'-6"	TD1	No	7'-0"	TD2	Yes	4'-6"	TD5	Yes	3	5	6	5	4	8	7	10
	1000		6	15'-6"	13'-0"	TD1	No	9'-0"	TD2	Yes	5'-6"	TD5	Yes	4	6	8	6	4	10	9	12
	1200		6	17'-6"	16'-0"	TD1	No	11'-0"	TD2	Yes	6'-6"	TD4	Yes	5	7	9	8	5	11	11	14
	1500		4	19'-6"	20'-0"	None	No	13'-6"	TD2	Yes	8'-0"	TD4	Yes	6	9	11	9	6	14	14	18
	2000		4	20'-0"	26'-6"	None	No	18'-0"	TD1	No	10'-6"	TD4	Yes	7	11	15	12	8	19	18	24

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - Approximate floor area _____
- Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- Include Earthquake Retrofit Schedule Sheets S3.1-1.0 thru S3.6-1.0 where applicable. See sheet S3, Figure 2 and schedule notes 6 and 7.

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
- Foundations: Where new foundations are required, see Sheet D2 for details.
- Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the _____ listed _____ capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Wall lengths are total length of a single wall section required. See Sheet S3.5-1.0 for 2 section of wall options.
- See Sheet S3.6-1.0 for Alternate Earthquake Retrofit Options where sufficient length of wall does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.

⑦

RETROFIT SUMMARY

BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

- Required length of strengthening at garage front wall line: (check box if tie-downs will be used on that line)
 Front Wall _____ft with Tie-Down Type _____
 Front Wall _____ft without Tie-Down
- New Foundation Sill Anchorage to be used: (check all that apply)
 Bolts: Diameter _____ Adhesive Screw
 Type "A" Connector Type "C" Connector
 Type "B" Connector
 Minimum required number of Sill Anchors per wall line _____
- Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)
 Type "D" Type "F"
 Type "E" Type "G"
 Minimum required number of Floor Framing Connectors per wall line _____
- Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧

Supplemental Earthquake Retrofit Schedule

- Check boxes if additional Earthquake Retrofit Schedules are included.
 S3.2-1.0 S3.4-1.0 S3.6-1.0
 S3.3-1.0 S3.5-1.0

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule at front of garage only in dwelling with Ground Floor Residential Unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.4-1.0

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.0) Two Sections of Wall at Front of Garage - Only

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	④ MINIMUM TOTAL REQUIRED LENGTH OF EACH SECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS For a Two Section of Wall Option						⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION		
			Length per Section for a Two Section Option						Min. No. of Foundation Connectors or Anchors at Each Section of Wall					Min. No. of Connectors at Each Section of Wall		
			8d at 6" O.C.			8d at 2" O.C.			Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
			Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?								
Light Construction	800		3'-6"	TD1	No	2'-8"	TD2	Yes	1	2	2	2	1	3	3	3
	1000		4'-0"	TD1	No	2'-8"	TD3	Yes	1	2	3	2	2	3	3	4
	1200		4'-6"	TD1	No	2'-8"	TD4	Yes	2	2	3	3	2	4	4	5
	1500		6'-0"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	4	6
	2000		8'-0"	TD1	No	3'-6"	TD4	Yes	2	4	5	4	3	6	6	7
Medium Construction	800		4'-0"	TD2	Yes	2'-8"	TD4	Yes	2	2	3	2	2	3	3	4
	1000		5'-0"	TD1	No	2'-8"	TD4	Yes	2	3	3	3	2	4	4	5
	1200		6'-0"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	5	6
	1500		7'-6"	TD1	No	3'-6"	TD5	Yes	2	4	5	4	3	6	6	7
	2000		10'-0"	TD1	No	4'-0"	TD5	Yes	3	5	6	5	4	7	7	9
Heavy Construction	800		5'-6"	TD1	No	2'-8"	TD4	Yes	2	3	3	3	2	4	4	5
	1000		6'-6"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	5	6
	1200		8'-0"	TD1	No	3'-6"	TD4	Yes	3	4	5	4	3	6	6	7
	1500		10'-0"	None	No	4'-0"	TD4	Yes	3	5	6	5	3	7	7	9
	2000		13'-0"	None	No	5'-6"	TD4	Yes	4	6	8	6	4	10	9	12

Notes:

1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per section of wall, placed within the length of strengthening where possible. Total number of anchor bolts and connectors shall equal twice the number shown in the schedule. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
3. Foundations: Where new foundations are required, see Sheet D2 for details.
4. Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
5. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
6. This Plan Set was developed using the [redacted] listed [redacted] capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
7. Wall lengths are minimum length of each wall section required on the garage front wall line.
8. See Sheet S3.6-1.0 for Alternate Earthquake Retrofit Options where sufficient length of wall panel does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- ④ Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- ⑤ Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- ⑥ Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑦ Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- ⑧ Include Earthquake Retrofit Schedule Sheets S3.1-1.0 thru S3.6-1.0 where applicable. See sheet S3, Figure 2 and schedule notes 6 and 7.

⑦ RETROFIT SUMMARY BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Required length of each section of strengthening per wall line: (check box if tie-downs will be used on that line)

Front Wall _____ft with Tie-Down Type _____

Front Wall _____ft without Tie-Down

2. New Foundation Sill Anchorage to be used: (check all that apply)

Bolts: Diameter _____ Adhesive Screw

Type "A" Connector Type "C" Connector

Type "B" Connector

Minimum required number of Sill Anchors per wall line _____

3. Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)

Type "D" Type "F"

Type "E" Type "G"

Minimum required number of Floor Framing Connectors per wall line _____

4. Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.

S3.1-1.0 S3.3-1.0 S3.6-1.0

S3.2-1.0 S3.4-1.0

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule at front of garage only in dwelling with Ground Floor Residential Unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings⁹

Date: _____
Sheet: _____

S3.5-1.0

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.0$) at front of Garage

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	STEEL COLUMN RETROFIT (2) (3)		PROPRIETARY SHEAR WALL RETROFIT (4) (5)	DIAPHRAGM NAILING (3) (5)
			Steel Column	Column Connection Type (per detail 2 on sheet D7) at Upper Floor	Minimum Required at Allowable Shear Capacity (lbs)	Edge Nail Spacing
Light Construction	800		W8x21	C1	1620	6
	1000		W8x21	C1	2030	6
	1200		W8x21	C1	2440	6
	1500		W8x21	C1	3050	6
	2000		W8x21	C1	4060	6
Medium Construction	800		W8x21	C1	2100	6
	1000		W8x21	C1	2630	6
	1200		W8x21	C1	3150	6
	1500		W8x21	C1	3940	6
	2000		W8x28	C1	5250	6
Heavy Construction	800		W8x21	C1	2740	6
	1000		W8x21	C1	3430	6
	1200		W8x21	C1	4120	6
	1500		W8x28	C1	5150	6
	2000		W8x28	C1	6860	6

Notes:

1. Steel column and Proprietary Shear Wall Options are provided for front of garage or back of garage or house only.
2. See detail 4 on Sheet D7 for footing detail at steel column retrofit.
3. See details 1 & 2 on Sheet D7 for steel column connections at upper floor.
4. See details 4 & 5 on Sheet D8 for footing details at proprietary shear wall.
5. See details 1 & 2 on Sheet D8 for upper floor connection at proprietary shear wall.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to steel column size and connection type or proprietary shear wall required.
- ④ Determine size of steel column and connection detail or see ⑤.
- ⑤ Determine minimum required allowable shear capacity to be used in selection of a proprietary shear wall. Consult manufacturer's load tables for final selection. Note that more than one shear wall panel may be needed to obtain the required shear capacity. Consult manufacturer's load tables for final selection.
- ⑥ See details 1 & 2 on sheet D7 for steel column connections at upper floor. See details 1 & 2 on sheet D8 for upper floor connection at proprietary shear wall.
- ⑦ Complete retrofit it summary below.

⑦ **RETROFIT SUMMARY**
check box if selected

Steel Column

At front wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

At back wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

Proprietary Shear Wall

At front wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

At back wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

⑧ **Supplemental Earthquake Retrofit Schedule**

1. Check boxes if additional Earthquake Retrofit Schedules are included.
- S3.1-1.0 S3.3-1.0 S3.5-1.0
 S3.2-1.0 S3.4-1.0

APPLICANT: _____
 PROPERTY ADDRESS: _____

Alternate Earthquake Retrofit Schedule at front of garage
 in dwelling w/ Ground Floor Residential Unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
 Sheet: _____

S3.6-1.0

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.2$) for Single Section of Wall

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="checked" type="checkbox"/>	④ MINIMUM REQUIRED LENGTH OF A SINGLE SECTION OF WALL OF WOOD STRUCTURAL PANEL SHEAR WALLS (at each wall line)											⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION		
			No Tie-down		w/ Tie-downs in Existing or New Foundations									Min. No. of Foundation Connectors or Anchors at Each Wall Panel					Min. No. of Connectors at Each Wall Panel		
					8d at 6" O.C.			8d at 4" O.C.			8d at 2" O.C.										
			8d Nail Spacing	Wall Length	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Type "A"	Type "B"	Type "C"	1/2" \emptyset Bolt	5/8" \emptyset Bolt	Type "D"	Type "E" or "F"	Type "G"
Light Construction	800		6	19'-0"	15'-0"	TD1	No	10'-6"	TD2	Yes	6'-0"	TD5	Yes	4	7	9	7	5	11	10	14
	1000		6	22'-6"	18'-6"	TD1	No	13'-0"	TD2	Yes	7'-6"	TD4	Yes	5	8	11	9	6	13	13	17
	1200		6	25'-6"	22'-6"	TD1	No	15'-6"	TD2	Yes	9'-0"	TD4	Yes	6	10	13	10	7	16	15	20
	1500		6	29'-6"	28'-0"	TD1	No	19'-0"	TD2	Yes	11'-6"	TD4	Yes	8	12	16	13	9	20	19	25
	2000		4	36'-0"	37'-6"	None	No	25'-6"	TD2	Yes	15'-0"	TD4	Yes	10	16	21	17	12	26	25	33
Medium Construction	800		6	23'-6"	19'-6"	TD1	No	13'-6"	TD2	Yes	8'-0"	TD5	Yes	5	8	11	9	6	14	13	17
	1000		6	27'-6"	24'-0"	TD1	No	16'-6"	TD2	Yes	10'-0"	TD4	Yes	7	10	14	11	8	17	17	22
	1200		6	31'-0"	29'-0"	TD1	No	20'-0"	TD2	Yes	12'-0"	TD4	Yes	8	12	16	13	9	21	20	26
	1500		4	35'-6"	36'-6"	None	No	25'-0"	TD2	Yes	15'-0"	TD4	Yes	10	15	20	17	11	26	25	32
	2000		4	43'-0"	48'-6"	None	No	33'-0"	TD2	Yes	19'-6"	TD4	Yes	13	20	27	22	15	34	33	43
Heavy Construction	800		4	24'-6"	25'-6"	None	No	17'-6"	TD2	Yes	10'-6"	TD4	Yes	7	11	14	12	8	18	17	23
	1000		4	28'-0"	31'-6"	None	No	21'-6"	TD2	Yes	13'-0"	TD4	Yes	9	13	18	15	10	22	21	28
	1200		4	31'-6"	38'-0"	None	No	26'-0"	TD1	No	15'-6"	TD4	Yes	10	16	21	17	12	27	26	34
	1500		4	34'-0"	47'-6"	None	No	32'-6"	TD1	No	19'-6"	TD4	Yes	13	20	26	22	15	33	32	42
	2000		2	34'-6"	"NG"	None	No	43'-6"	None	No	25'-6"	TD3	Yes	17	26	35	29	20	44	42	56

INSTRUCTIONS

1. Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
2. Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
a. Approximate floor area _____
3. Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
4. Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
5. Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2" \emptyset or 5/8" \emptyset anchor bolts. (\emptyset = diameter of the bolts.) See Sheet S3.
6. Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
7. Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
8. Include Earthquake Retrofit Schedule Sheets S3.1-1.2 thru S3.6-1.2 where applicable. See sheet S3, Figure 2 and schedule notes 6 thru 8.

Notes:

1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
3. Foundations: Where new foundations are required at front and back walls, see Sheet D2 for details. At side walls, select retrofit options that do not require new foundations whenever possible. Otherwise, provide foundations that extend the full depth of the garage in Figures 4 and 5 on Sheet S0 and for Figure 3 conditions (*living-space-over-garage dwellings without ground floor residential unit*), consult a Registered Design Professional for remedial direction.
4. Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
5. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
6. This Plan Set was developed using the listed capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
7. Wall lengths are total length of a single wall section required on each side of the building. See Sheet S3.2-1.2 for 2 section of wall options.
8. See Sheet S3.3-1.2 for Alternate Earthquake Retrofit Options where sufficient length of wall does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.
9. See Sheets S3.4-1.2 thru S3.6-1.2 for Earthquake Retrofit Schedules for the front wall only at dwellings with a ground story residential unit. See also Sheet S0, Figure 2.

⑦ RETROFIT SUMMARY BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Retrofit requirements per wall line: (check box if tie-down and/or new footing will be used on that line)
 Front Wall _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
 Back Wall _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
 Left Side Walls _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
 Right Side Walls _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
2. New Foundation Sill Anchorage to be used: (check all that apply)
Bolts: Diameter _____ Adhesive Screw
 Type "A" Connector Type "C" Connector
 Type "B" Connector
Minimum required number of Sill Anchors per wall line _____
3. Floor Framing Connectors (to Top Plate) to be used: (check all that apply)
 Type "D" Type "F"
 Type "E" Type "G"
Minimum required number of Floor Framing Connectors per wall line _____
4. Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.
 S3.2-1.2 S3.4-1.2 S3.6-1.2
 S3.3-1.2 S3.5-1.2

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - Wood Structural Panel with
single section of wall

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.1-1.2

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.2$) Two Sections of Wall																
① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	④ MINIMUM TOTAL REQUIRED LENGTH OF EACH SECTION OF WOOD STRUCTURAL PANEL SHEAR WALL For a Two Section of Wall Option					⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION			
			Length per Section for a Two Section Option					Min. No. of Foundation Connectors or Anchors at Each Section of Wall					Min. No. of Connectors at Each Section of Wall			
			8d at 6" O.C.		8d at 2" O.C.			Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"	
			Wall Length	Tie- down	New Fdn Req'd ?	Wall Length	Tie- down									New Fdn Req'd ?
Light Construction	800		7'-6"	TD1	No	3'-6"	TD4	Yes	2	4	5	4	3	6	5	7
	1000		9'-6"	TD1	No	4'-0"	TD4	Yes	3	4	6	5	3	7	7	9
	1200		11'-6"	TD1	No	4'-6"	TD5	Yes	3	5	7	5	4	8	8	10
	1500		14'-0"	TD1	No	6'-0"	TD4	Yes	4	6	8	7	5	10	10	13
	2000		19'-0"	None	No	7'-6"	TD4	Yes	5	8	11	9	6	13	13	17
Medium Construction	800		9'-6"	TD1	No	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9
	1000		12'-0"	TD1	No	5'-0"	TD5	Yes	4	5	7	6	4	9	9	11
	1200		14'-6"	TD1	No	6'-0"	TD4	Yes	4	6	8	7	5	11	10	13
	1500		18'-0"	None	No	7'-6"	TD4	Yes	5	8	10	9	6	13	13	16
	2000		24'-6"	None	No	10'-0"	TD4	Yes	7	10	14	11	8	17	17	22
Heavy Construction	800		12'-6"	None	No	5'-0"	TD4	Yes	4	6	7	6	4	9	9	12
	1000		16'-0"	None	No	6'-6"	TD4	Yes	5	7	9	8	5	11	11	14
	1200		19'-0"	None	No	8'-0"	TD4	Yes	5	8	11	9	6	14	13	17
	1500		24'-0"	None	No	9'-6"	TD4	Yes	7	10	13	11	8	17	16	21
	2000		"NG"	None	No	13'-0"	TD3	Yes	9	13	18	15	10	22	21	28

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- ④ Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- ⑤ Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- ⑥ Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑦ Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- ⑧ Include Earthquake Retrofit Schedule Sheets S3.1-1.2 thru S3.6-1.2 where applicable. See sheet S3, Figure 2 and schedule notes 6 thru 8.

- Notes:**
1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per section of wall, placed within the length of strengthening where possible. Total number of anchor bolts and connectors shall equal twice the number shown in the schedule. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
 2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
 3. Foundations: Where new foundations are required at front and back walls, see Sheet D2 for details. At side walls, select retrofit options that do not require new foundations whenever possible. Otherwise, provide foundations that extend the full depth of the garage in Figures 4 and 5 on Sheet S0 and for Figure 3 conditions (*living-space-over-garage* dwellings without *ground floor residential unit*), consult a Registered Design Professional for remedial direction.
 4. Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
 5. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
 6. This Plan Set was developed using the _____ listed _____ capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
 7. Wall lengths are total length of wall required on each side of the building. You may use 2 sections of wall per line based on existing building conditions but each section must be at least 3 feet long and each individual section shall not be greater than 55% of the total require length. (See Figure D-6 on Sheets S0).
 8. See Sheet S3.3-1.2 for Alternate Earthquake Retrofit Options where sufficient length of wall panel does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.
 9. See Sheets S3.4-1.2 thru S3.6-1.2 for Earthquake Retrofit Schedules for the front wall only at dwellings with a ground story residential unit. See also Sheet S0, Figure 2.

⑦ RETROFIT SUMMARY
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Retrofit requirements at each section of wall, per wall line: (check box if tie-down and/or new footing will be used on that line)

Front Wall _____ ft Nailing: 8d at _____ O.C. Tie-Down Type _____ New Ftg
 Back Wall _____ ft Nailing: 8d at _____ O.C. Tie-Down Type _____ New Ftg
 Left Side Walls _____ ft Nailing: 8d at _____ O.C. Tie-Down Type _____ New Ftg
 Right Side Walls _____ ft Nailing: 8d at _____ O.C. Tie-Down Type _____ New Ftg

1. New Foundation Sill Anchorage to be used: (check all that apply)

Bolts: Diameter _____ Adhesive Screw

Type "A" Connector Type "C" Connector
 Type "B" Connector
 Minimum required number of Sill Anchors at each section of wall, per wall line _____

3. Floor Framing Connectors (to Top Plate) to be used: (check all that apply)

Type "D" Type "F"
 Type "E" Type "G"
 Minimum required number of Floor Framing Connectors at each section of wall, per wall line _____

4. Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

1. Check if this Sheet is supplemental to sheet S3.1, otherwise check if additional retrofit schedule are required.

S3.2-1.2 S3.4-1.2 S3.6-1.2
 S3.3-1.2 S3.5-1.2

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - Wood Structural Panel with two sections of wall

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.2-1.2

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.2)

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	④ STEEL COLUMN RETROFIT (2) (3)		⑤ PROPRIETARY SHEAR WALL RETROFIT (4) (5)	⑥ DIAPHRAGM NAILING (3) (5)
			Steel Column	Column Connection Type (per detail 2 on sheet D7) at Upper Floor	Minimum Required at Allowable Shear Capacity (lbs)	Edge Nail Spacing
Light Construction	800		W8x21	C1	3900	6
	1000		W8x28	C1	4870	6
	1200		W8x28	C1	5850	6
	1500		W10x26	C2	7310	6
	2000		W12x35	C2	9740	6
Medium Construction	800		W8x28	C1	5040	6
	1000		W8x28	C1	6300	6
	1200		W10x30	C2	7560	4
	1500		W12x35	C2	9450	4
	2000		W10x45	C3	12,600	4
Heavy Construction	800		W8x28	C1	6590	4
	1000		W10x30	C2	8230	4
	1200		W12x35	C2	9880	3
	1500		W12x35	C3	12,400	3
	2000		"NG"	"NG"	16,500	3

Notes:

1. Steel column and Proprietary Shear Wall Options are provided for front of garage or back of garage or house only.
2. See detail 4 on Sheet D7 for footing detail at steel column retrofit.
3. See details 1 & 2 on Sheet D7 for steel column connections at upper floor.
4. See details 4 & 5 on Sheet D8 for footing details at proprietary shear wall.
5. See details 1 & 2 on Sheet D8 for upper floor connection at proprietary shear wall.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.

a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to select the steel column size and connection type or proprietary shear wall required.
- ④ Determine size of steel column and connection detail or see ⑤.
- ⑤ Determine minimum required allowable shear capacity to be used in selection of a proprietary shear wall. Note that more than one shear wall panel may be needed to obtain the required shear capacity. Consult manufacturer's load tables for final selection.
- ⑥ See details 1 & 2 on sheet D7 for steel column connections at upper floor. See details 1 & 2 on sheet D8 for upper floor connection at proprietary shear wall.
- ⑦ Complete retrofit summary below.

⑦ RETROFIT SUMMARY
check box if selected

Steel Column

At front wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

At back wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

Proprietary Shear Wall

At front wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

At back wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.
- S3.1-1.2 S3.3-1.2 S3.5-1.2
 S3.2-1.2 S3.4-1.2

APPLICANT: _____
 PROPERTY ADDRESS: _____

Alternate Earthquake Retrofit Schedule (Steel Column or Proprietary Shear Wall)

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
 Sheet: _____

S3.3-1.2

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.2) for Single Section of Wall at Front of Garage - Only

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	④ MINIMUM REQUIRED LENGTH OF A SINGLE SECTION OF WALL OF WOOD STRUCTURAL PANEL SHEAR WALLS (at each wall line)											⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION				
			No Tie-down		w/ Tie-downs in Existing or New Foundations											Min. No. of Foundation Connectors or Anchors at Each Wall Panel					Min. No. of Connectors at Each Wall Panel		
					8d at 6" O.C.				8d at 4" O.C.				8d at 2" O.C.										
			8d Nail Spacing	Wall Length	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"		
Light Construction	800		6	11'-6"	7'-6"	TD1	No	5'-0"	TD3	Yes	3'-6"	TD5	Yes	2	4	5	4	3	6	5	7		
	1000		6	13'-6"	9'-6"	TD1	No	6'-6"	TD2	Yes	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9		
	1200		6	15'-6"	11'-0"	TD1	No	7'-6"	TD2	Yes	4'-6"	TD5	Yes	3	5	7	5	4	8	8	10		
	1500		6	18'-0"	14'-0"	TD1	No	9'-6"	TD2	Yes	5'-6"	TD5	Yes	4	6	8	7	5	10	10	13		
	2000		6	22'-6"	18'-6"	TD1	No	13'-0"	TD2	Yes	7'-6"	TD4	Yes	5	8	11	9	6	13	13	17		
Medium Construction	800		6	14'-6"	9'-6"	TD1	No	6'-6"	TD3	Yes	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9		
	1000		6	17'-0"	12'-0"	TD1	No	8'-6"	TD2	Yes	5'-0"	TD5	Yes	4	5	7	6	4	9	9	11		
	1200		6	19'-0"	14'-6"	TD1	No	10'-0"	TD2	Yes	6'-0"	TD5	Yes	4	6	8	7	5	11	10	13		
	1500		6	22'-6"	18'-0"	TD1	No	12'-6"	TD2	Yes	7'-6"	TD5	Yes	5	8	10	9	6	13	13	16		
	2000		6	27'-6"	24'-0"	TD1	No	16'-6"	TD2	Yes	10'-0"	TD5	Yes	7	10	14	11	8	17	17	22		
Heavy Construction	800		6	15'-6"	12'-6"	TD1	No	8'-6"	TD2	Yes	5'-0"	TD5	Yes	4	6	7	6	4	9	9	12		
	1000		6	18'-0"	16'-0"	TD1	No	11'-0"	TD2	Yes	6'-6"	TD5	Yes	5	7	9	8	5	11	11	14		
	1200		6	20'-6"	19'-0"	TD1	No	13'-0"	TD2	Yes	7'-6"	TD4	Yes	5	8	11	9	6	14	13	17		
	1500		4	22'-0"	23'-6"	None	No	16'-0"	TD2	Yes	9'-6"	TD4	Yes	7	10	13	11	8	17	16	21		
	2000		4	23'-0"	31'-6"	None	No	21'-6"	TD1	No	13'-0"	TD4	Yes	9	13	18	15	10	22	21	28		

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- ④ Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- ⑤ Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- ⑥ Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑦ Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- ⑧ Include Earthquake Retrofit Schedule Sheets S3.1-1.2 thru S3.6-1.2 where applicable. See sheet S3, Figure 2 and schedule notes 6 and 7.

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - at front of garage only in dwelling with ground story residential unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Notes:

- 1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
- 2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
- 3. Foundations: Where new foundations are required, see Sheet D2 for details.
- 4. Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- 5. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- 6. This Plan Set was developed using the _____ listed _____ capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- 7. Wall lengths are total length of a single wall section required. See Sheet S3.5-1.2 for 2 section of wall options.
- 8. See Sheet S3.6-1.2 for Alternate Earthquake Retrofit Options where sufficient length of wall does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.

⑦

RETROFIT SUMMARY

BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

- 1. Required length of strengthening at garage front wall line: (check box if tie-downs will be used on that line)
Front Wall _____ft with Tie-Down Type _____
Front Wall _____ft without Tie-Down
- 2. New Foundation Sill Anchorage to be used: (check all that apply)
Bolts: Diameter _____ Adhesive Screw
 Type "A" Connector Type "C" Connector
 Type "B" Connector
Minimum required number of Sill Anchors per wall line _____
- 3. Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)
 Type "D" Type "F"
 Type "E" Type "G"
Minimum required number of Floor Framing Connectors per wall line _____
- 4. Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧

Supplemental Earthquake Retrofit Schedule

- 1. Check boxes if additional Earthquake Retrofit Schedules are included.
 S3.2-1.2 S3.4-1.2 S3.6-1.2
 S3.3-1.2 S3.5-1.2

Date: _____

Sheet: _____

S3.4-1.2

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.2$) Two Sections of Wall at Front of Garage - Only

1 WEIGHT CLASSIFICATION	2 Floor Area in Square Feet	3 Mark row that applies <input type="checkbox"/>	4 MINIMUM TOTAL REQUIRED LENGTH OF EACH SECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS For a Two Section of Wall Option						5 FOUNDATION SILL ANCHORAGE Min. No. of Foundation Connectors or Anchors at Each Section of Wall					6 FLOOR FRAMING TO WALL CONNECTION Min. No. of Connectors at Each Section of Wall					
			Length per Section for a Two Section Option									Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
			8d at 6" O.C.			8d at 2" O.C.													
			Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?											
Light Construction	800	<input type="checkbox"/>	4'-0"	TD1	No	2'-6"	TD3	Yes	1	2	3	2	2	3	3	4			
	1000	<input type="checkbox"/>	4'-6"	TD1	No	2'-6"	TD4	Yes	2	2	3	3	2	4	4	5			
	1200	<input type="checkbox"/>	5'-6"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	4	4	5			
	1500	<input type="checkbox"/>	7'-0"	TD1	No	3'-0"	TD4	Yes	2	3	4	4	3	5	5	7			
	2000	<input type="checkbox"/>	9'-6"	TD1	No	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9			
Medium Construction	800	<input type="checkbox"/>	5'-0"	TD2	Yes	2'-6"	TD4	Yes	2	2	3	3	2	4	4	5			
	1000	<input type="checkbox"/>	6'-0"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	5	6			
	1200	<input type="checkbox"/>	7'-6"	TD1	No	3'-6"	TD5	Yes	2	3	4	4	3	6	5	7			
	1500	<input type="checkbox"/>	9'-0"	TD1	No	4'-0"	TD5	Yes	3	4	5	5	3	7	7	8			
	2000	<input type="checkbox"/>	12'-0"	TD1	No	5'-0"	TD5	Yes	4	5	7	6	4	9	9	11			
Heavy Construction	800	<input type="checkbox"/>	6'-6"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	5	6			
	1000	<input type="checkbox"/>	8'-0"	TD1	No	3'-6"	TD4	Yes	3	4	5	4	3	6	6	7			
	1200	<input type="checkbox"/>	9'-6"	TD1	No	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9			
	1500	<input type="checkbox"/>	12'-0"	None	No	5'-0"	TD4	Yes	4	5	7	6	4	9	8	11			
	2000	<input type="checkbox"/>	16'-0"	None	No	6'-6"	TD4	Yes	5	7	9	8	5	11	11	14			

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per section of wall, placed within the length of strengthening where possible. Total number of anchor bolts and connectors shall equal twice the number shown in the schedule. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
- Foundations: Where new foundations are required, see Sheet D2 for details.
- Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the ██████████ listed ██████████ capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Wall lengths are minimum length of each wall section required on the garage front wall line.
- See Sheet S3.6-1.2 for Alternate Earthquake Retrofit Options where sufficient length of wall panel does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- Check the box that matches your home's area per 2. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths found in 4 for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- Include Earthquake Retrofit Schedule Sheets S3.1-1.2 thru S3.6-1.2 where applicable. See sheet S3, Figure 2 and schedule notes 6 and 7.

7 **RETROFIT SUMMARY**
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

- Required length of each section of strengthening per wall line: (check box if tie-downs will be used on that line)

Front Wall _____ft with Tie-Down Type _____

Front Wall _____ft without Tie-Down
- New Foundation Sill Anchorage to be used: (check all that apply)

Bolts: Diameter _____ Adhesive Screw

Type "A" Connector Type "C" Connector

Type "B" Connector

Minimum required number of Sill Anchors per wall line _____
- Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)

Type "D" Type "F"

Type "E" Type "G"

Minimum required number of Floor Framing Connectors per wall line _____
- Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

8 **Supplemental Earthquake Retrofit Schedule**

- Check boxes if additional Earthquake Retrofit Schedules are included.

S3.1-1.2 S3.3-1.2 S3.6-1.2

S3.2-1.2 S3.4-1.2

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule at front of garage only in dwelling with ground story residential unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet:

S3.5-1.2

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.2) at front of Garage

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	STEEL COLUMN RETROFIT (2) (3)		PROPRIETARY SHEAR WALL RETROFIT (4) (5)	DIAPHRAGM NAILING (3) (5)
			Steel Column	Column Connection Type (per detail 2 on sheet D7) at Upper Floor	Minimum Required at Allowable Shear Capacity (lbs)	Edge Nail Spacing (inches on center)
Light Construction	800		W8x21	C1	1950	6
	1000		W8x21	C1	2440	6
	1200		W8x21	C1	2920	6
	1500		W8x21	C1	3650	6
	2000		W8x28	C1	4870	6
Medium Construction	800		W8x21	C1	2520	6
	1000		W8x21	C1	3150	6
	1200		W8x21	C1	3780	6
	1500		W8x28	C1	4730	6
	2000		W8x28	C1	6300	6
Heavy Construction	800		W8x21	C1	3290	6
	1000		W8x21	C1	4120	6
	1200		W8x28	C1	4940	6
	1500		W8x28	C1	6170	6
	2000		W10x30	C2	8230	6

Notes:

- Steel column and Proprietary Shear Wall Options are provided for front of garage or back of garage or house only.
- See detail 4 on Sheet D7 for footing detail at steel column retrofit.
- See details 1 & 2 on Sheet D7 for steel column connections at upper floor.
- See details 4 & 5 on Sheet D8 for footing details at proprietary shear wall.
- See details 1 & 2 on Sheet D8 for upper floor connection at proprietary shear wall.

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - Approximate floor area _____
- Check the box that matches your home's area per ②. You will use information in this row of the schedule to steel column size and connection type or proprietary shear wall required.
- Determine size of steel column and connection detail or see ⑤.
- Determine minimum required allowable shear capacity to be used in selection of a proprietary shear wall. Consult manufacturer's load tables for final selection. Note that more than one shear wall panel may be needed to obtain the required shear capacity. Consult manufacturer's load tables for final selection.
- See details 1 & 2 on sheet D7 for steel column connections at upper floor. See details 1 & 2 on sheet D8 for upper floor connection at proprietary shear wall.
- Complete retrofit it summary below.

⑦ **RETROFIT SUMMARY**
check box if selected

Steel Column

At front wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

At back wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

Proprietary Shear Wall

At front wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

At back wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

⑧ **Supplemental Earthquake Retrofit Schedule**

1. Check boxes if additional Earthquake Retrofit Schedules are included.
- S3.1-1.2 S3.3-1.2 S3.5-1.2
 S3.2-1.2 S3.4-1.2

APPLICANT: _____
 PROPERTY ADDRESS: _____

Alternate Earthquake Retrofit Schedule at front of garage
 in dwelling w/ ground story residential unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
 Sheet: _____

S3.6-1.2

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.5) for Single Section of Wall

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.

a. Approximate floor area _____
- Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"ø or 5/8"ø anchor bolts. (ø = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- Include Earthquake Retrofit Schedule Sheets S3.1-1.5 thru S3.6-1.5 where applicable. See sheet S3, Figure 2 and schedule notes 6 thru 8.

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	④ MINIMUM REQUIRED LENGTH OF A SINGLE SECTION OF WALL OF WOOD STRUCTURAL PANEL SHEAR WALLS (at each wall line)										⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION			
			No Tie-down			w/ Tie-downs in Existing or New Foundations							Min. No. of Foundation Connectors or Anchors at Each Wall Panel					Min. No. of Connectors at Each Wall Panel			
			8d Nail Spacing	Wall Length	Wall Length	8d at 6" O.C.		8d at 4" O.C.		8d at 2" O.C.			Type "A"	Type "B"	Type "C"	1/2"ø Bolt	5/8"ø Bolt	Type "D"	Type "E" or "F"	Type "G"	
Tie-down	New Fdn Req'd ?	Wall Length				Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?											
Light Construction	800		6	23'-0"	18'-6"	TD1	No	13'-0"	TD2	Yes	7'-6"	TD4	Yes	5	8	11	9	6	13	13	17
	1000		6	27'-0"	23'-6"	TD1	No	16'-0"	TD2	Yes	9'-6"	TD4	Yes	6	10	13	11	8	17	16	21
	1200		6	30'-6"	28'-0"	TD1	No	19'-0"	TD2	Yes	11'-6"	TD4	Yes	8	12	16	13	9	20	19	25
	1500		4	35'-0"	35'-0"	None	No	24'-0"	TD2	Yes	14'-6"	TD4	Yes	9	15	19	16	11	25	24	31
	2000		4	43'-0"	47'-0"	None	No	32'-0"	TD2	Yes	19'-0"	TD4	Yes	12	20	26	21	15	33	31	42
Medium Construction	800		6	28'-6"	24'-0"	TD1	No	16'-6"	TD2	Yes	10'-0"	TD5	Yes	7	10	14	11	8	17	17	22
	1000		6	33'-0"	30'-6"	TD1	No	20'-6"	TD2	Yes	12'-6"	TD4	Yes	8	13	17	14	10	21	21	27
	1200		6	37'-0"	36'-6"	TD1	No	25'-0"	TD2	Yes	15'-0"	TD4	Yes	10	15	20	17	11	26	25	32
	1500		4	42'-6"	45'-6"	None	No	31'-0"	TD2	Yes	18'-6"	TD4	Yes	12	19	25	21	14	32	31	40
	2000		4	51'-6"	"NG"	None	No	41'-6"	TD1	No	24'-6"	TD4	Yes	16	25	33	27	19	42	41	54
Heavy Construction	800		4	29'-6"	31'-6"	None	No	21'-6"	TD2	Yes	13'-0"	TD4	Yes	9	13	18	15	10	22	21	28
	1000		4	33'-6"	39'-6"	None	No	27'-0"	TD1	No	16'-0"	TD4	Yes	11	17	22	18	12	28	27	35
	1200		4	37'-6"	47'-6"	None	No	32'-6"	TD1	No	19'-6"	TD4	Yes	13	20	26	22	15	33	32	42
	1500		2	40'-6"	"NG"	None	No	40'-6"	None	No	24'-0"	TD4	Yes	16	25	32	27	18	41	40	53
	2000		2	41'-0"	"NG"	None	No	54'-0"	None	No	32'-0"	TD2	Yes	21	33	43	36	24	55	53	70

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
- Foundations: Where new foundations are required at front and back walls, see Sheet D2 for details. At side walls, select retrofit options that do not require new foundations whenever possible. Otherwise, provide foundations that extend the full depth of the garage in Figures 4 and 5 on Sheet S0 and for Figure 3 conditions (*living-space-over-garage dwellings without ground floor residential unit*), consult a Registered Design Professional for remedial direction.
- Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the listed capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Wall lengths are total length of a single wall section required on each side of the building. See Sheet S3.2-1.5 for 2 section of wall options.
- See Sheet S3.3-1.5 for Alternate Earthquake Retrofit Options where sufficient length of wall does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.
- See Sheets S3.4-1.5 thru S3.6-1.5 for Earthquake Retrofit Schedules for the front wall only at dwellings with a ground story residential unit. See also Sheet S0, Figure 2.

⑦ **RETROFIT SUMMARY**
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

- Retrofit requirements per wall line: (check box if tie-down and/or new footing will be used on that line)

Front Wall _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg

Back Wall _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg

Left Side Walls _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg

Right Side Walls _____ ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
- New Foundation Sill Anchorage to be used: (check all that apply)

Bolts: Diameter _____ Adhesive Screw

Type "A" Connector Type "C" Connector

Type "B" Connector

Minimum required number of Sill Anchors per wall line _____
- Floor Framing Connectors (to Top Plate) to be used: (check all that apply)

Type "D" Type "F"

Type "E" Type "G"

Minimum required number of Floor Framing Connectors per wall line _____
- Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ **Supplemental Earthquake Retrofit Schedule**

- Check boxes if additional Earthquake Retrofit Schedules are included.

S3.2-1.5 S3.4-1.5 S3.6-1.5

S3.3-1.5 S3.5-1.5

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - Wood Structural Panel with single section of wall

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.1-1.5

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.5$) Two Sections of Wall

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	④ MINIMUM TOTAL REQUIRED LENGTH OF EACH SECTION OF WOOD STRUCTURAL PANEL SHEAR WALL For a Two Section of Wall Option					⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION			
			Length per Section for a Two Section Option					Min. No. of Foundation Connectors or Anchors at Each Section of Wall					Min. No. of Connectors at Each Section of Wall			
			8d at 6" O.C.		8d at 2" O.C.			Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"	
			Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down									New Fdn Req'd ?
Light Construction	800		9'-6"	TD1	No	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9
	1000		12'-0"	TD1	No	5'-0"	TD5	Yes	3	5	7	6	4	9	8	11
	1200		14'-0"	TD1	No	6'-0"	TD4	Yes	4	6	8	7	5	10	10	13
	1500		17'-6"	TD1	No	7'-0"	TD4	Yes	5	8	10	8	6	13	12	16
	2000		23'-6"	None	No	9'-6"	TD4	Yes	6	10	13	11	8	17	16	21
Medium Construction	800		12'-0"	TD1	No	5'-0"	TD5	Yes	4	5	7	6	4	9	9	11
	1000		15'-0"	TD1	No	6'-0"	TD5	Yes	4	7	9	7	5	11	11	14
	1200		18'-0"	TD1	No	7'-6"	TD4	Yes	5	8	10	9	6	13	13	16
	1500		23'-0"	None	No	9'-6"	TD4	Yes	6	10	13	11	7	16	16	20
	2000		"NG"	None	No	12'-6"	TD4	Yes	8	13	17	14	10	21	21	27
Heavy Construction	800		16'-0"	None	No	6'-6"	TD4	Yes	5	7	9	8	5	11	11	14
	1000		20'-0"	None	No	8'-0"	TD4	Yes	6	9	11	9	6	14	14	18
	1200		24'-0"	None	No	9'-6"	TD4	Yes	7	10	13	11	8	17	16	21
	1500		"NG"	None	No	12'-0"	TD4	Yes	8	13	16	14	9	21	20	27
	2000		"NG"	None	No	16'-0"	TD2	Yes	11	17	22	18	12	28	27	35

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per section of wall, placed within the length of strengthening where possible. Total number of anchor bolts and connectors shall equal twice the number shown in the schedule. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
- Foundations: Where new foundations are required at front and back walls, see Sheet D2 for details. At side walls, select retrofit options that do not require new foundations whenever possible. Otherwise, provide foundations that extend the full depth of the garage in Figures 4 and 5 on Sheet S0 and for Figure 3 conditions (*living-space-over-garage dwellings without ground floor residential unit*), consult a Registered Design Professional for remedial direction.
- Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the listed capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Wall lengths are total length of wall required on each side of the building. You may use 2 sections of wall per line based on existing building conditions but each section must be at least 3 feet long and each individual section shall not be greater than 55% of the total require length. (See Figure D-6 on Sheets S0).
- See Sheet S3.3-1.5 for Alternate Earthquake Retrofit Options where sufficient length of wall panel does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.
- See Sheets S3.4-1.5 thru S3.6-1.5 for Earthquake Retrofit Schedules for the front wall only at dwellings with a ground story residential unit. See also Sheet S0, Figure 2.

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - Approximate floor area _____
- Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- Include Earthquake Retrofit Schedule Sheets S3.1-1.5 thru S3.6-1.5 where applicable. See sheet S3, Figure 2 and schedule notes 6 thru 8.

**⑦ RETROFIT SUMMARY
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS**

1. Retrofit requirements at each section of wall, per wall line: (check box if tie-down and/or new footing will be used on that line)

Front Wall _____ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
 Back Wall _____ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
 Left Side Walls _____ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg
 Right Side Walls _____ft Nailing: 8d at ____ O.C. Tie-Down Type _____ New Ftg

2. New Foundation Sill Anchorage to be used: (check all that apply)

Bolts: Diameter _____ Adhesive Screw
 Type "A" Connector Type "C" Connector
 Type "B" Connector
 Minimum required number of Sill Anchors at each section of wall, per wall line _____

3. Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)

Type "D" Type "F"
 Type "E" Type "G"
 Minimum required number of Floor Framing Connectors at each section of wall, per wall line _____

4. Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

1. Check if this Sheet is supplemental to sheet S3.1, otherwise check if additional retrofit schedule are required.

S3.2-1.5 S3.4-1.5 S3.6-1.5
 S3.3-1.5 S3.5-1.5

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - Wood Structural Panel with two sections of wall

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.2-1.5

EARTHQUAKE RETROFIT SCHEDULE ($S_{DS} = 1.5$)

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	④ STEEL COLUMN RETROFIT (2) (3)		⑤ PROPRIETARY SHEAR WALL RETROFIT (4) (5)	⑥ DIAPHRAGM NAILING (3) (5)
			Steel Column	Column Connection Type (per detail 2 on sheet D7) at Upper Floor	Minimum Required at Allowable Shear Capacity (lbs)	Edge Nail Spacing
Light Construction	800		W8x28	C1	4870	6
	1000		W8x28	C1	6090	6
	1200		W10x26	C2	7310	4
	1500		W12x35	C2	9140	4
	2000		W12x35	C3	12,200	4
Medium Construction	800		W8x28	C1	6300	4
	1000		W10x30	C2	7880	4
	1200		W12x35	C2	9450	4
	1500		W12x35	C3	11,800	3
	2000		"NG"	"NG"	15,800	3
Heavy Construction	800		W10x30	C2	8230	3
	1000		W12x35	C3	10,300	3
	1200		W12x35	C3	12,300	3
	1500		"NG"	"NG"	15,400	3
	2000		"NG"	"NG"	20,600	3

Notes:

1. Steel column and Proprietary Shear Wall Options are provided for front of garage or back of garage or house only.
2. See detail 4 on Sheet D7 for footing detail at steel column retrofit.
3. See details 1 & 2 on Sheet D7 for steel column connections at upper floor.
4. See details 4 & 5 on Sheet D8 for footing details at proprietary shear wall.
5. See details 1 & 2 on Sheet D8 for upper floor connection at proprietary shear wall.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to select the steel column size and connection type or proprietary shear wall required.
- ④ Determine size of steel column and connection detail or see ⑤.
- ⑤ Determine minimum required allowable shear capacity to be used in selection of a proprietary shear wall. Note that more than one shear wall panel may be needed to obtain the required shear capacity. Consult manufacturer's load tables for final selection.
- ⑥ See details 1 & 2 on sheet D7 for steel column connections at upper floor. See details 1 & 2 on sheet D8 for upper floor connection at proprietary shear wall.
- ⑦ Complete retrofit summary below.

⑦ RETROFIT SUMMARY
check box if selected

Steel Column

At front wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

At back wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

Proprietary Shear Wall

At front wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

At back wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.
- S3.1-1.5 S3.3-1.5 S3.5-1.5
 S3.2-1.5 S3.4-1.5

APPLICANT: _____
 PROPERTY ADDRESS: _____

Alternate Earthquake Retrofit Schedule (Steel Column or Proprietary Shear Wall)

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
 Sheet: _____

S3.3-1.5

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.5) for Single Section of Wall at Front of Garage - Only

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	④ MINIMUM REQUIRED LENGTH OF A SINGLE SECTION OF WALL OF WOOD STRUCTURAL PANEL SHEAR WALLS (at each wall line)											⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION			
			No Tie-down			w/ Tie-downs in Existing or New Foundations								Min. No. of Foundation Connectors or Anchors at Each Wall Panel					Min. No. of Connectors at Each Wall Panel			
						8d at 6" O.C.			8d at 4" O.C.			8d at 2" O.C.			Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
			8d Nail Spacing	Wall Length	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"	
Light Construction	800		6	14'-0"	9'-6"	TD1	No	6'-6"	TD3	Yes	4'-0"	TD5	Yes	3	4	6	5	3	7	7	9	
	1000		6	16'-6"	11'-6"	TD1	No	8'-0"	TD2	Yes	5'-0"	TD5	Yes	3	5	7	6	4	9	8	11	
	1200		6	18'-6"	14'-0"	TD1	No	9'-6"	TD2	Yes	5'-6"	TD5	Yes	4	6	8	7	5	10	10	13	
	1500		6	22'-0"	17'-6"	TD1	No	12'-0"	TD2	Yes	7'-0"	TD4	Yes	5	8	10	8	6	13	12	16	
	2000		6	27'-0"	23'-6"	TD1	No	16'-0"	TD2	Yes	9'-6"	TD4	Yes	6	10	13	11	8	17	16	21	
Medium Construction	800		6	17'-6"	12'-0"	TD1	No	8'-6"	TD3	Yes	5'-0"	TD5	Yes	4	5	7	6	4	9	9	11	
	1000		6	20'-6"	15'-0"	TD1	No	10'-6"	TD2	Yes	6'-0"	TD5	Yes	4	7	9	7	5	11	11	14	
	1200		6	23'-0"	18'-0"	TD1	No	12'-6"	TD2	Yes	7'-6"	TD5	Yes	5	8	10	9	6	13	13	16	
	1500		6	27'-0"	22'-6"	TD1	No	15'-6"	TD2	Yes	9'-0"	TD4	Yes	6	10	13	11	7	16	16	20	
	2000		6	33'-0"	30'-6"	TD1	No	20'-6"	TD2	Yes	12'-6"	TD4	Yes	8	13	17	14	10	21	21	27	
Heavy Construction	800		6	18'-6"	16'-0"	TD1	No	11'-0"	TD2	Yes	6'-6"	TD5	Yes	5	7	9	8	5	11	11	14	
	1000		6	21'-6"	20'-0"	TD1	No	13'-6"	TD2	Yes	8'-0"	TD4	Yes	6	9	11	9	6	14	14	18	
	1200		6	24'-6"	23'-6"	TD1	No	16'-0"	TD2	Yes	9'-6"	TD4	Yes	7	10	13	11	8	17	16	21	
	1500		4	26'-6"	29'-6"	None	No	20'-6"	TD2	Yes	12'-0"	TD4	Yes	8	13	16	14	9	21	20	27	
	2000		4	27'-6"	39'-6"	None	No	27'-0"	TD1	No	16'-0"	TD4	Yes	11	17	22	18	12	28	27	35	

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.

a. Approximate floor area _____
- Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- Include Earthquake Retrofit Schedule Sheets S3.1-1.5 thru S3.6-1.5 where applicable. See sheet S3, Figure 2 and schedule notes 6 and 7.

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
- Foundations: Where new foundations are required, see Sheet D2 for details.
- Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the _____ listed _____ capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Wall lengths are total length of a single wall section required. See Sheet S3.5-1.5 for 2 section of wall options.
- See Sheet S3.6-1.5 for Alternate Earthquake Retrofit Options where sufficient length of wall does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.

**⑦ RETROFIT SUMMARY
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS**

- Required length of strengthening at garage front wall line: (check box if tie-downs will be used on that line)
 Front Wall _____ft with Tie-Down Type _____
 Front Wall _____ft without Tie-Down
- New Foundation Sill Anchorage to be used: (check all that apply)
 Bolts: Diameter _____ Adhesive Screw
 Type "A" Connector Type "C" Connector
 Type "B" Connector
 Minimum required number of Sill Anchors per wall line _____
- Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)
 Type "D" Type "F"
 Type "E" Type "G"
 Minimum required number of Floor Framing Connectors per wall line _____
- Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

- Check boxes if additional Earthquake Retrofit Schedules are included.
 S3.2-1.5 S3.4-1.5 S3.6-1.5
 S3.3-1.5 S3.5-1.5

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule - at front of garage only in dwelling with ground story residential unit
Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.4-1.5

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.5) Two Sections of Wall at Front of Garage - Only

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	④ MINIMUM TOTAL REQUIRED LENGTH OF EACH SECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS For a Two Section of Wall Option					⑤ FOUNDATION SILL ANCHORAGE					⑥ FLOOR FRAMING TO WALL CONNECTION					
			Length per Section for a Two Section Option								Min. No. of Foundation Connectors or Anchors at Each Section of Wall					Min. No. of Connectors at Each Section of Wall		
			8d at 6" O.C.			8d at 2" O.C.			Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"		
			Wall Length	Tie-down	New Fdn Req'd ?	Wall Length	Tie-down	New Fdn Req'd ?										
Light Construction	800		4'-6"	TD1	No	2'-6"	TD4	Yes	2	2	3	3	2	4	4	5		
	1000		6'-0"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	4	6		
	1200		7'-0"	TD1	No	3'-0"	TD4	Yes	2	3	4	4	3	5	5	7		
	1500		9'-0"	TD1	No	4'-0"	TD4	Yes	3	4	5	4	3	7	6	8		
	2000		12'-0"	TD1	No	5'-0"	TD5	Yes	3	5	7	6	4	9	8	11		
Medium Construction	800		6'-0"	TD1	No	3'-0"	TD4	Yes	2	3	4	3	2	5	5	6		
	1000		7'-6"	TD1	No	3'-6"	TD5	Yes	2	4	5	4	3	6	6	7		
	1200		9'-0"	TD1	No	4'-0"	TD5	Yes	3	4	5	5	3	7	7	8		
	1500		11'-6"	TD1	No	4'-6"	TD5	Yes	3	5	7	6	4	8	8	10		
	2000		15'-0"	TD1	No	6'-0"	TD5	Yes	4	7	9	7	5	11	11	14		
Heavy Construction	800		8'-0"	TD1	No	3'-6"	TD4	Yes	3	4	5	4	3	6	6	7		
	1000		10'-0"	TD1	No	4'-0"	TD4	Yes	3	5	6	5	3	7	7	9		
	1200		12'-0"	TD1	No	5'-0"	TD4	Yes	4	5	7	6	4	9	8	11		
	1500		15'-0"	None	No	6'-0"	TD4	Yes	4	7	8	7	5	11	10	14		
	2000		20'-0"	None	No	8'-0"	TD4	Yes	6	9	11	9	6	14	14	18		

Notes:

1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per section of wall, placed within the length of strengthening where possible. Total number of anchor bolts and connectors shall equal twice the number shown in the schedule. Additional anchors and connectors may be necessary to meet the requirements of specific details and General Notes.
2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.) Where "None" occurs, no tie-down is required.
3. Foundations: Where new foundations are required, see Sheet D2 for details.
4. Connector Type "F" should be used as an alternative only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
5. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
6. This Plan Set was developed using the listed capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
7. Wall lengths are minimum length of each wall section required on the garage front wall line.
8. See Sheet S3.6-1.5 for Alternate Earthquake Retrofit Options where sufficient length of wall panel does not occur or where wood structural panel shear wall retrofit installations are otherwise prohibited.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to determine length of plywood bracing panels, nailing requirements, quantities of hardware, etc.
- ④ Determine the length of plywood bracing required. The columns contain the length of required bracing, including options for bracing without tie-downs, with tie-downs into existing foundations and tie-downs w/ new foundations, see schedule Note 3. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for each side of the house (front, back, left side, right side).
- ⑤ Determine the number of Foundation Sill Connectors or Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or number of 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- ⑥ Determine the number of Floor to Wall connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑦ Complete the Retrofit Summary for your project. Fill in the lengths found in ④ for each line. If no option is available, see Schedule notes 6 & 7. Check the boxes for the anchor and connector types you plan to use. If you intend to use tie-downs, check the box for tie-downs after each wall line you plan to use them for, check the box on line 4, and read the Supplemental Technical Notes for additional information.
- ⑧ Include Earthquake Retrofit Schedule Sheets S3.1-1.5 thru S3.6-1.5 where applicable. See sheet S3, Figure 2 and schedule notes 6 and 7.

⑦ RETROFIT SUMMARY BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Required length of each section of strengthening per wall line: (check box if tie-downs will be used on that line)
 Front Wall _____ft with Tie-Down Type _____
 Front Wall _____ft without Tie-Down
2. New Foundation Sill Anchorage to be used: (check all that apply)
 Bolts: Diameter _____ Adhesive Screw
 Type "A" Connector Type "C" Connector
 Type "B" Connector
 Minimum required number of Sill Anchors per wall line _____
3. Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)
 Type "D" Type "F"
 Type "E" Type "G"
 Minimum required number of Floor Framing Connectors per wall line _____
4. Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.
 S3.1-1.5 S3.3-1.5 S3.6-1.5
 S3.2-1.5 S3.4-1.5

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule at front of garage only in dwelling with ground story residential unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet:

S3.5-1.5

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.5) at front of Garage

① WEIGHT CLASSIFICATION	② Floor Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	STEEL COLUMN RETROFIT (2) (3)		PROPRIETARY SHEAR WALL RETROFIT (4) (5)	DIAPHRAGM NAILING (3) (5)
			Steel Column	Column Connection Type (per detail 2 on sheet D7) at Upper Floor	Minimum Required at Allowable Shear Capacity (lbs)	Edge Nail Spacing
Light Construction	800		W8x21	C1	2440	6
	1000		W8x21	C1	3050	6
	1200		W8x21	C1	3650	6
	1500		W8x21	C1	4570	6
	2000		W8x28	C1	6090	6
Medium Construction	800		W8x21	C1	3150	6
	1000		W8x21	C1	3940	6
	1200		W8x28	C1	4730	6
	1500		W8x28	C1	5910	6
	2000		W10x30	C2	7880	6
Heavy Construction	800		W8x21	C1	4120	6
	1000		W8x28	C1	5150	6
	1200		W8x28	C1	6170	6
	1500		W10x30	C2	7720	6
	2000		W12x35	C3	10,300	6

Notes:

1. Steel column and Proprietary Shear Wall Options are provided for front of garage or back of garage or house only.
2. See detail 4 on Sheet D7 for footing detail at steel column retrofit.
3. See details 1 & 2 on Sheet D7 for steel column connections at upper floor.
4. See details 4 & 5 on Sheet D8 for footing details at proprietary shear wall.
5. See details 1 & 2 on Sheet D8 for upper floor connection at proprietary shear wall.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Floor Area "B" x "L" (See Figures D-3 thru D-5) in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate floor area _____
- ③ Check the box that matches your home's area per ②. You will use information in this row of the schedule to steel column size and connection type or proprietary shear wall required.
- ④ Determine size of steel column and connection detail or see ⑤.
- ⑤ Determine minimum required allowable shear capacity to be used in selection of a proprietary shear wall. Consult manufacturer's load tables for final selection. Note that more than one shear wall panel may be needed to obtain the required shear capacity. Consult manufacturer's load tables for final selection.
- ⑥ See details 1 & 2 on sheet D7 for steel column connections at upper floor. See details 1 & 2 on sheet D8 for upper floor connection at proprietary shear wall.
- ⑦ Complete retrofit it summary below.

⑦ RETROFIT SUMMARY
check box if selected

Steel Column

At front wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

At back wall
 Column Size _____
 Connection _____
 Diaphragm Nailing _____

Proprietary Shear Wall

At front wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

At back wall
 Req'd Capacity _____
 MFR/ Size _____
 Diaphragm Nailing _____

⑧ Supplemental Earthquake Retrofit Schedule

1. Check boxes if additional Earthquake Retrofit Schedules are included.
- S3.1-1.5 S3.3-1.5 S3.5-1.5
 S3.2-1.5 S3.4-1.5

APPLICANT: _____
 PROPERTY ADDRESS: _____

Alternate Earthquake Retrofit Sched. at front of garage in dwelling w/ ground story residential unit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
 Sheet: _____

S3.6-1.5

RETROFIT SCHEDULE SUMMARY





See the Retrofit Summary on the Sheet indicated below for additional requirements on each wall line.

Front Wall _____
Back Wall _____
Left Side Wall _____
Right Side Wall _____

General Sheet Notes:

1. For Shear Wall Framing at walls without Tie-Downs, see Det. 1/D4.
2. For Shear Wall Framing at walls with Tie-Downs, see Det. 1/D5.
3. For wall sheathing cutouts, see Det. 3/D6.
4. For wall stud and top plate penetrations, see Det. 4/D6.
5. For wall top plate splices, see Det. 1/D6 at existing double top plates and Det. 2/D6 at single top plates.

Key:

-  Retrofit shear wall edge nail spacing per the Earthquake Retrofit Schedule. # denotes the edge nail spacing.
-  Foundation sill anchor bolt or connector, number per line per the Retrofit Schedule
-  Floor to wall framing connector, number per line per the Retrofit Schedule
-  Tie-down. # denotes the tie down size per schedule, see sheet S3.

ONE SQUARE = ____ FEET

Show north arrow and indicate street side (front) of home.

Date:

Sheet:

S4

Foundation and Retrofit Layout Plan

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

APPLICANT: _____

PROPERTY ADDRESS: _____

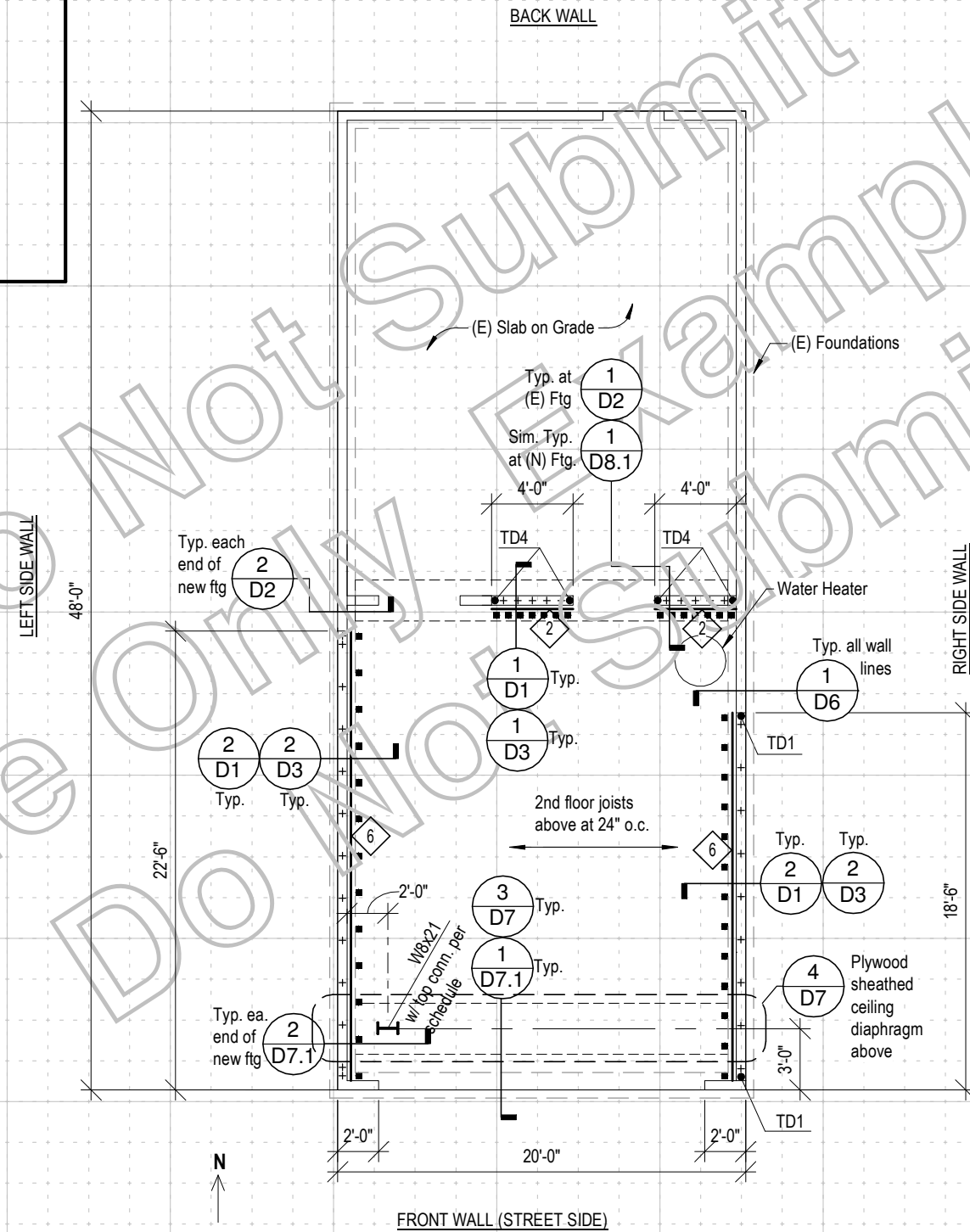
RETROFIT SCHEDULE SUMMARY

See the Retrofit Summary on the Sheet indicated below for additional requirements on each wall line.

Front Wall	S3.6-1.2
Back Wall	S3.2-1.2
Left Side Wall	S3.1-1.2
Right Side Wall	S3.1-1.2

General Sheet Notes:

1. For Shear Wall Framing at walls without Tie-Downs, see Det. 1/D4.
2. For Shear Wall Framing at walls with Tie-Downs, see Det. 1/D5.
3. For wall sheathing cutouts, see Det. 3/D6.
4. For wall stud and top plate penetrations, see Det. 4/D6.
5. For wall top plate splices, see Det. 1/D6 at existing double top plates and Det. 2/D6 at single top plates.



Key:

- Retrofit shear wall edge nail spacing per the Earthquake Retrofit Schedule. # denotes the edge nail spacing.
- Foundation sill anchor bolt or connector, number per line per the Retrofit Schedule
- Floor to wall framing connector, number per line per the Retrofit Schedule
- Tie-down. # denotes the tie down size per schedule, see sheet S3.

ONE SQUARE = 2 FEET

APPLICANT: _____
PROPERTY ADDRESS: _____

Foundation and Retrofit Layout Plan

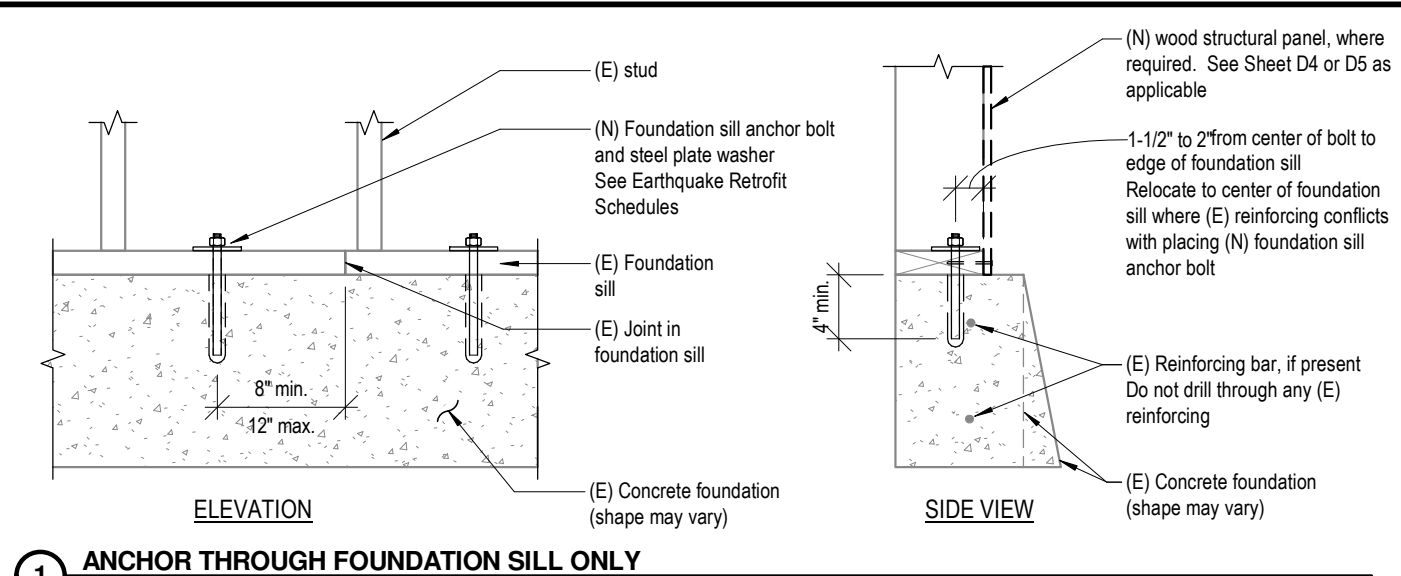
Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)

Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

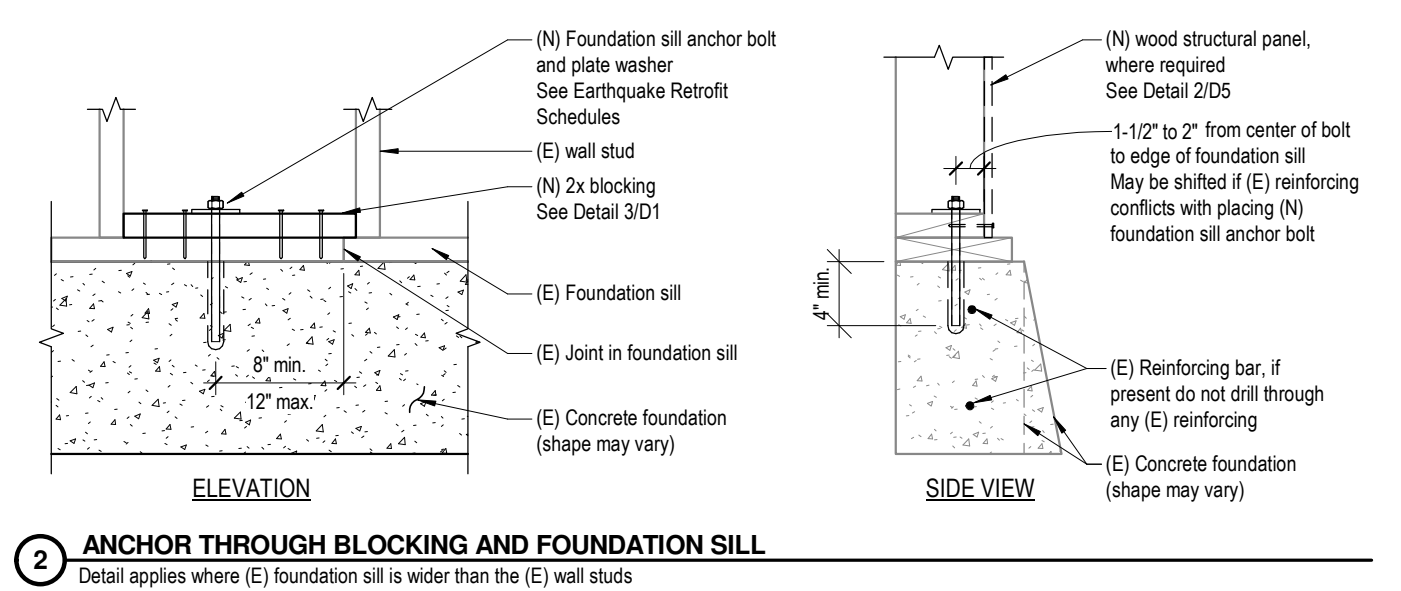
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Sheet: _____

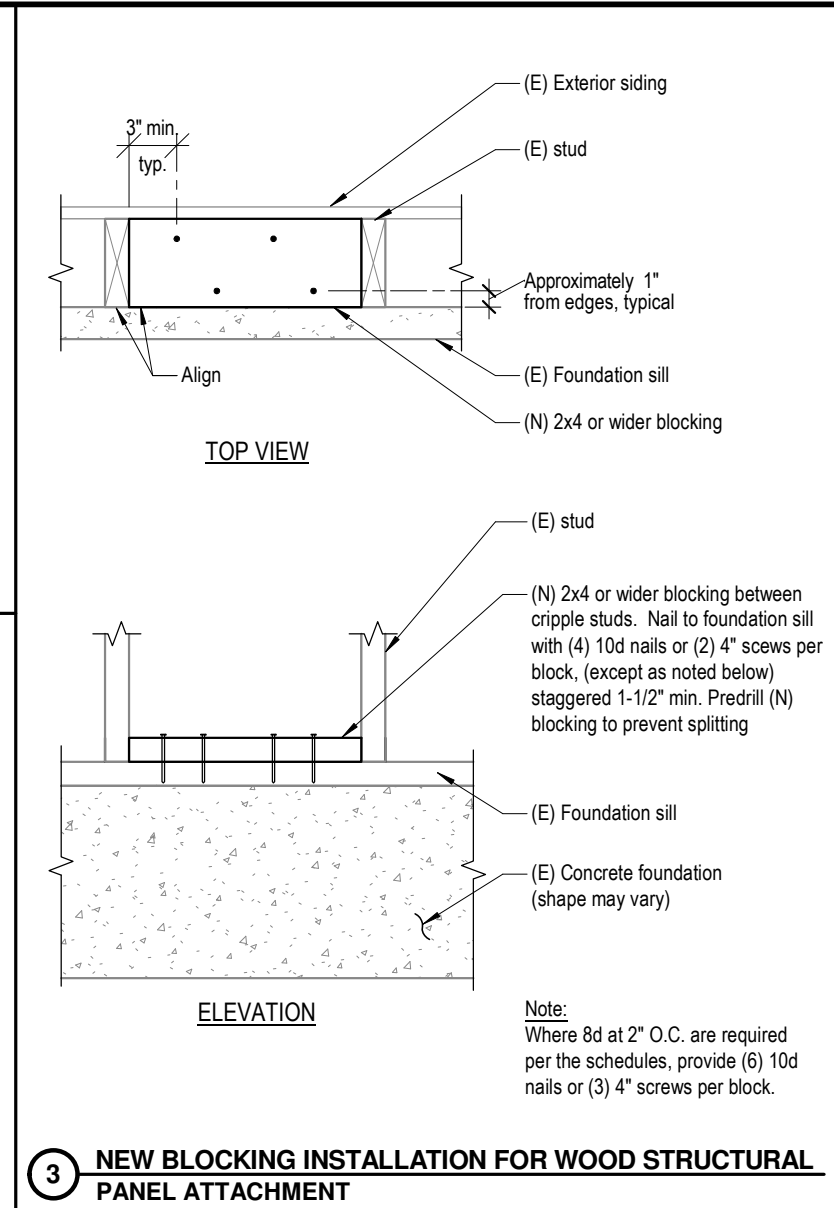
S4ex



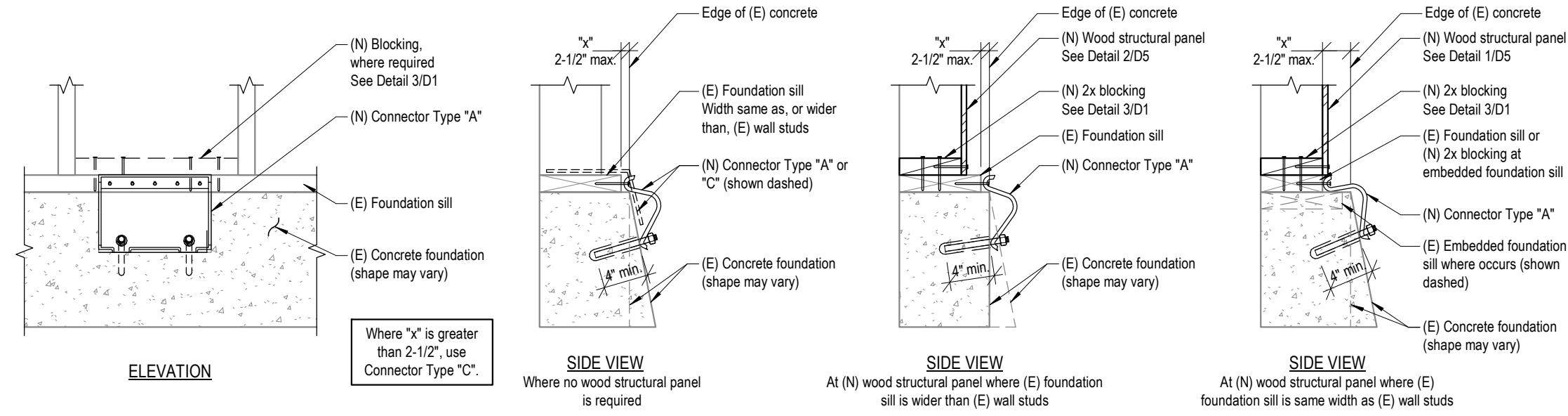
1 ANCHOR THROUGH FOUNDATION SILL ONLY
Detail applies where (E) foundation sill is the same width as the (E) wall studs



2 ANCHOR THROUGH BLOCKING AND FOUNDATION SILL
Detail applies where (E) foundation sill is wider than the (E) wall studs



3 NEW BLOCKING INSTALLATION FOR WOOD STRUCTURAL PANEL ATTACHMENT



4 FOUNDATION SILL CONNECTORS

MATERIAL KEY:
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	

For Connector types see Sheet S3.

ABBREVIATIONS

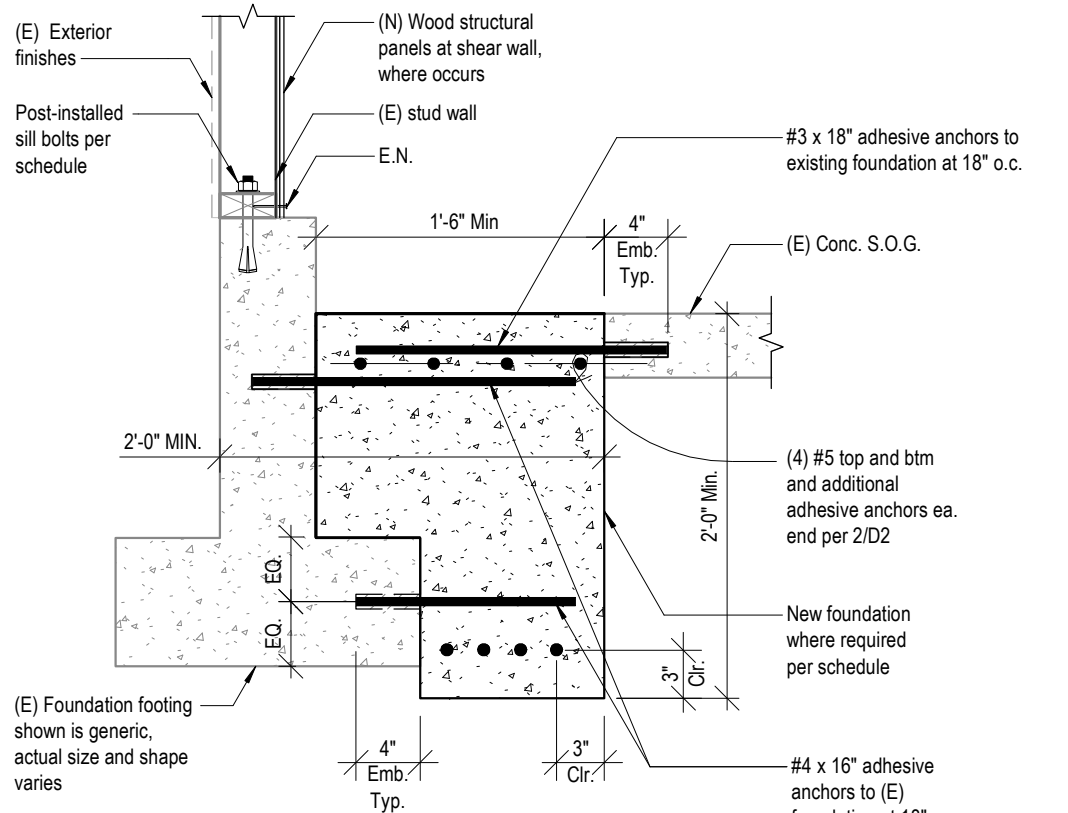
Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ. w/	Typical with

APPLICANT: _____
PROPERTY ADDRESS: _____

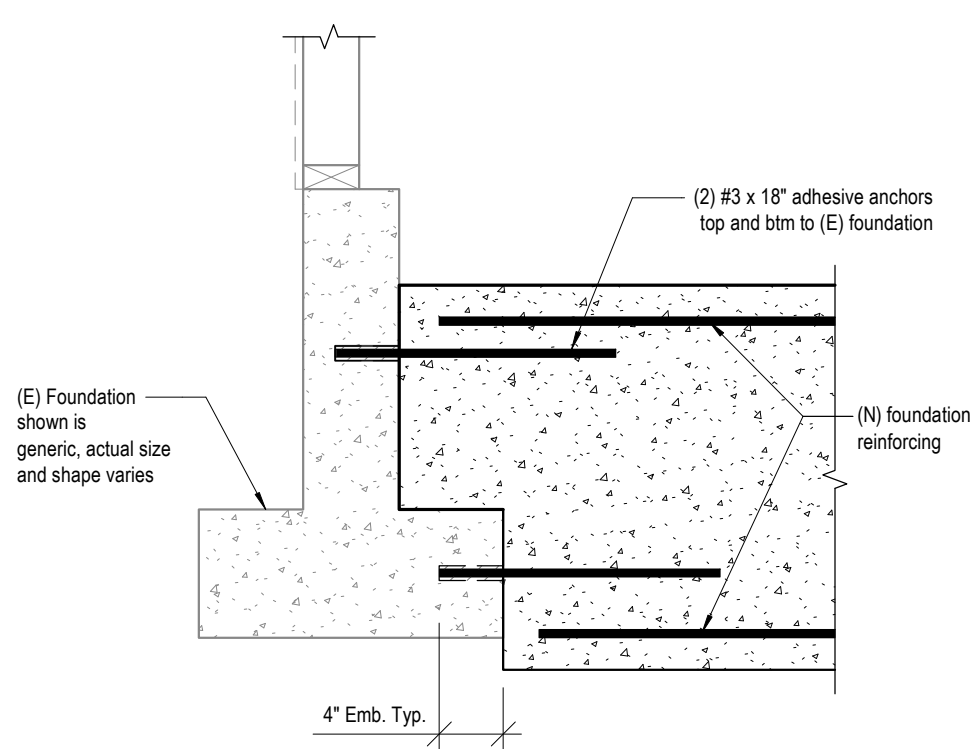
Foundation Sill to Concrete Foundation Connection Details

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

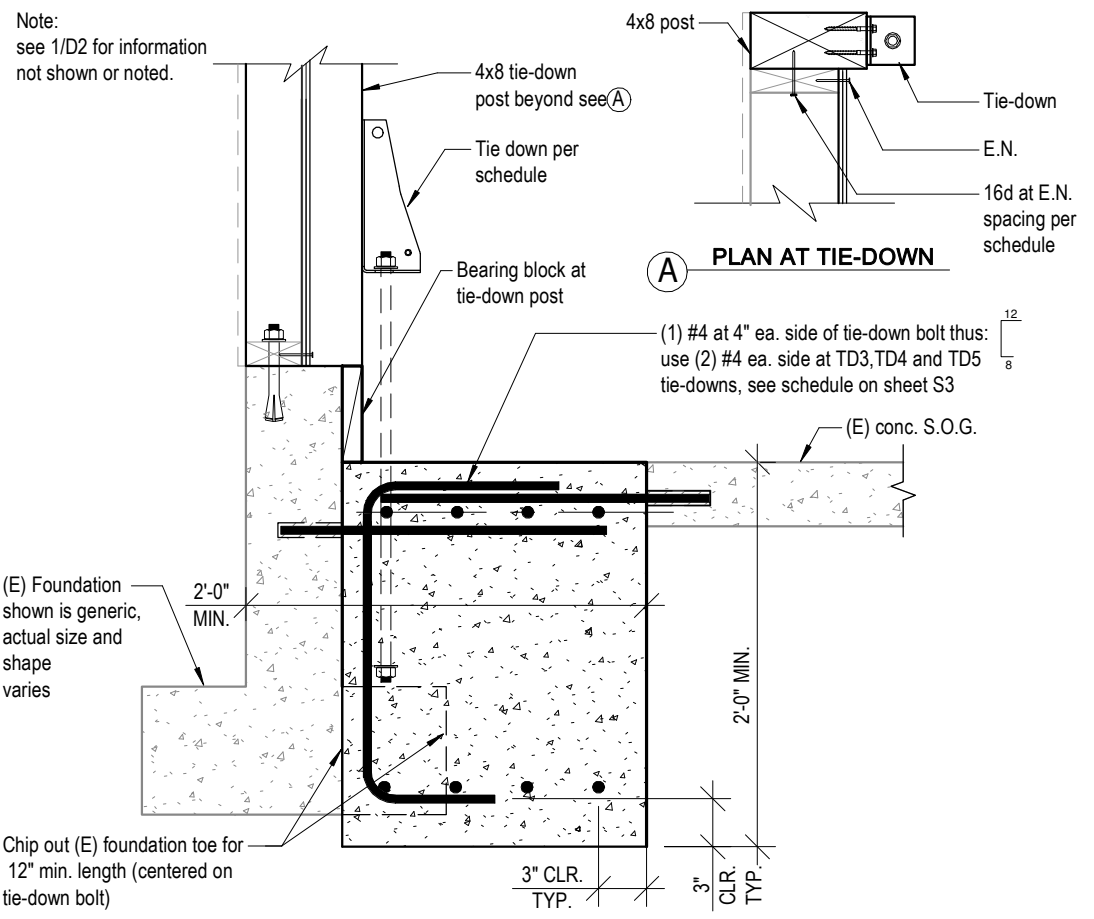
Date: _____
Sheet: **D1**



1 NEW FOOTING INSTALLATION AT NEW WOOD STRUCTURAL PANEL SHEAR WALL



2 TIES FROM NEW TO EXISTING FOUNDATION



3 TYPICAL TIE-DOWN AT NEW FOUNDATION

MATERIAL KEY:
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	

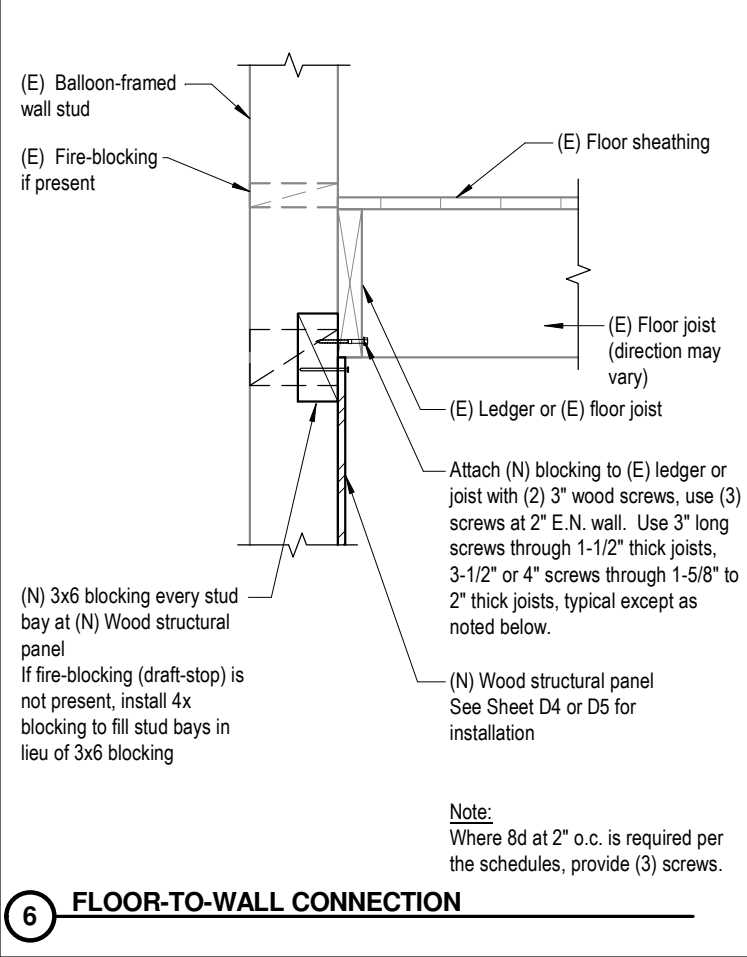
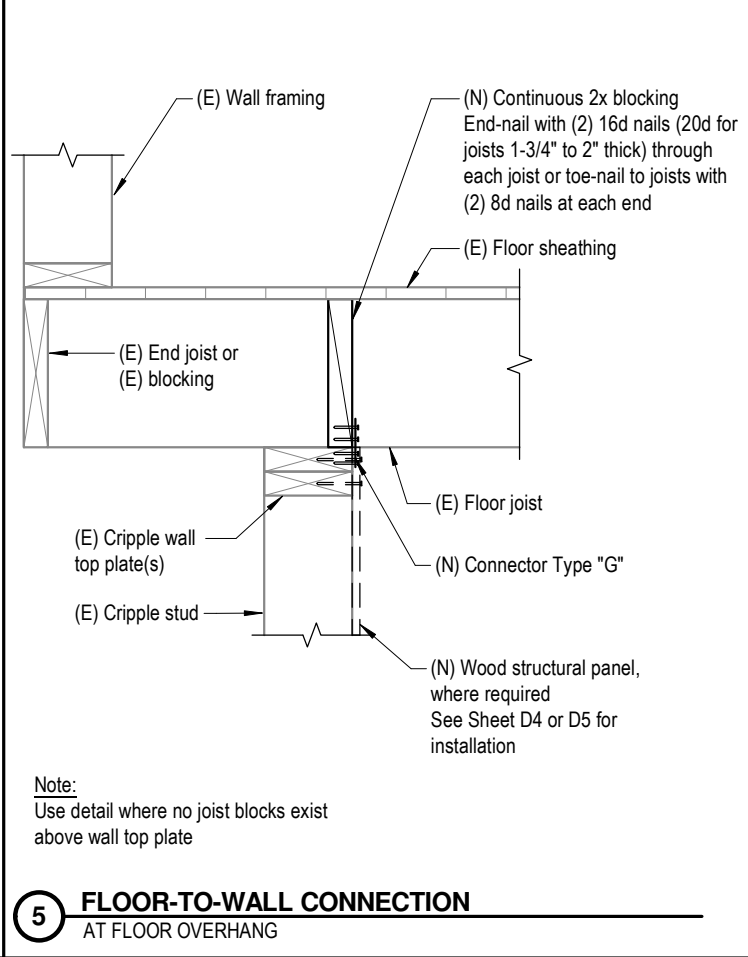
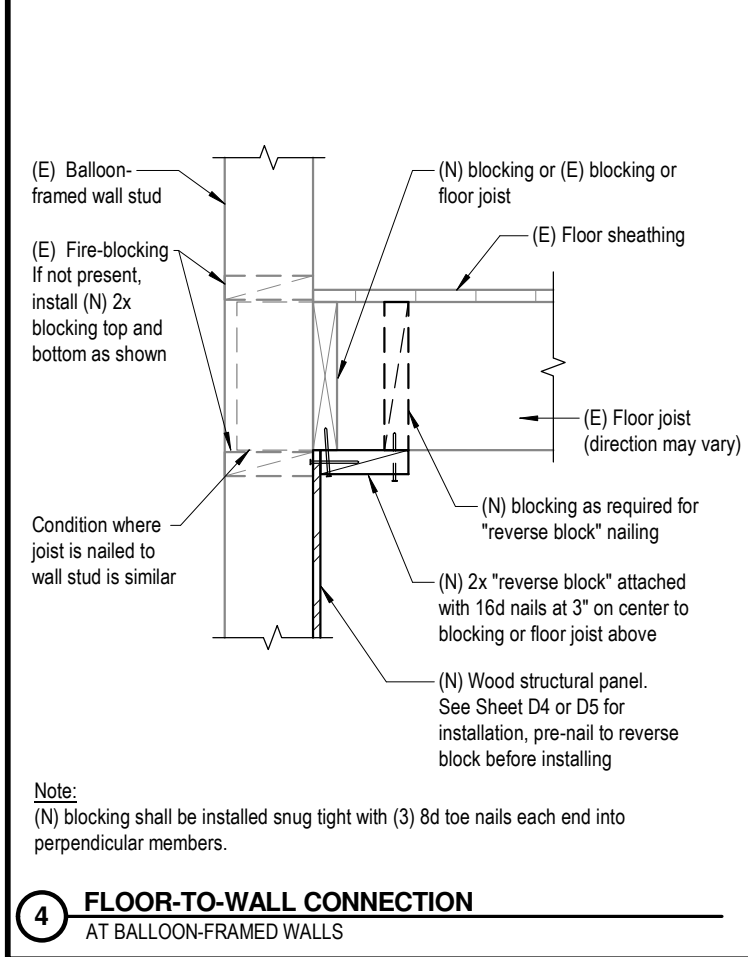
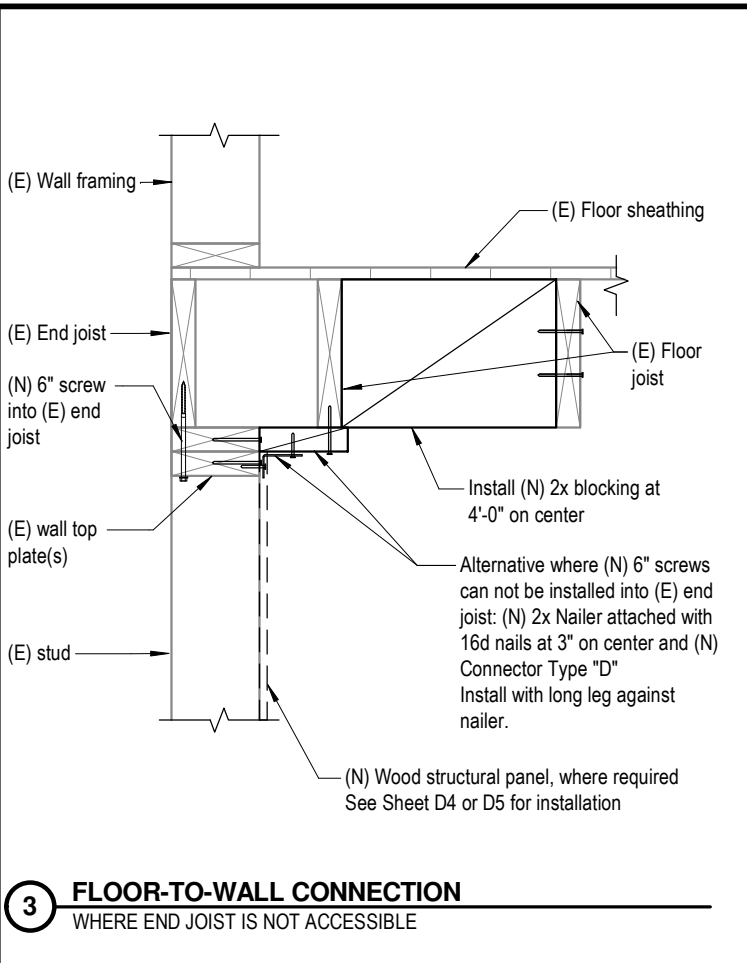
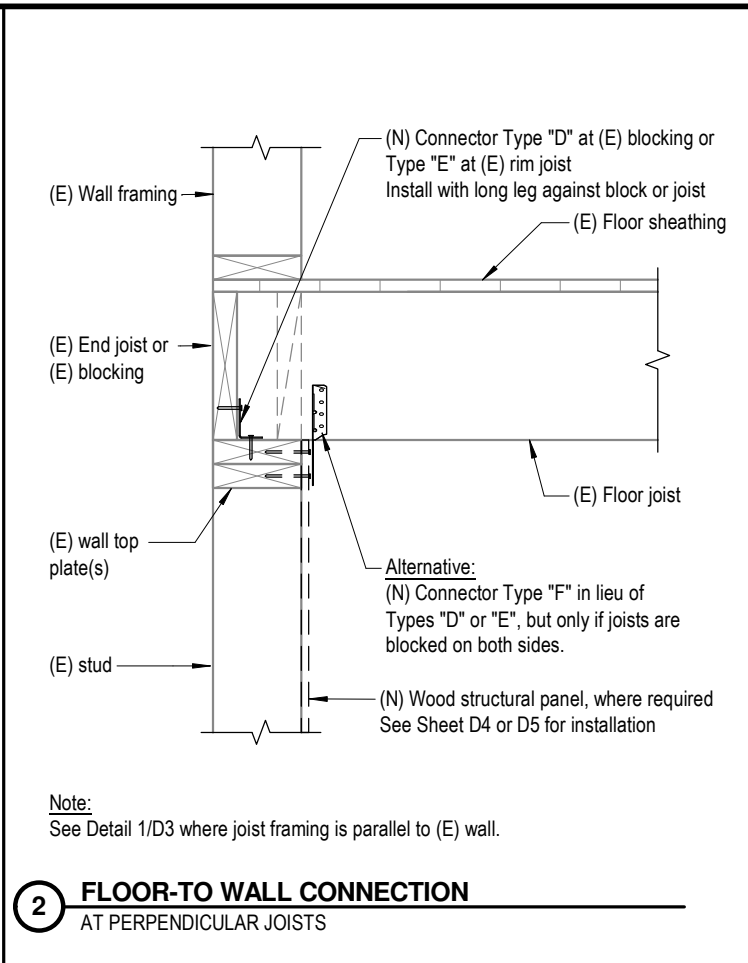
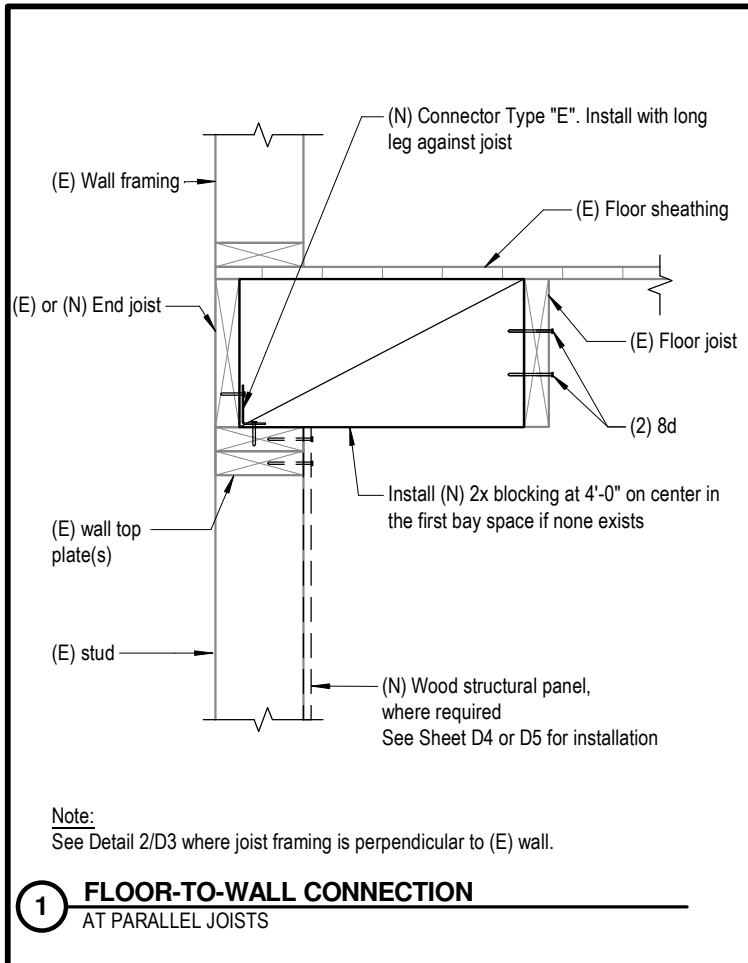
ABBREVIATIONS

Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

APPLICANT: _____
PROPERTY ADDRESS: _____

Foundation Details at Wood Structural Panel Shear Walls
Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D2**



MATERIAL KEY:
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	
For Connector types see Sheet S3.	

ABBREVIATIONS

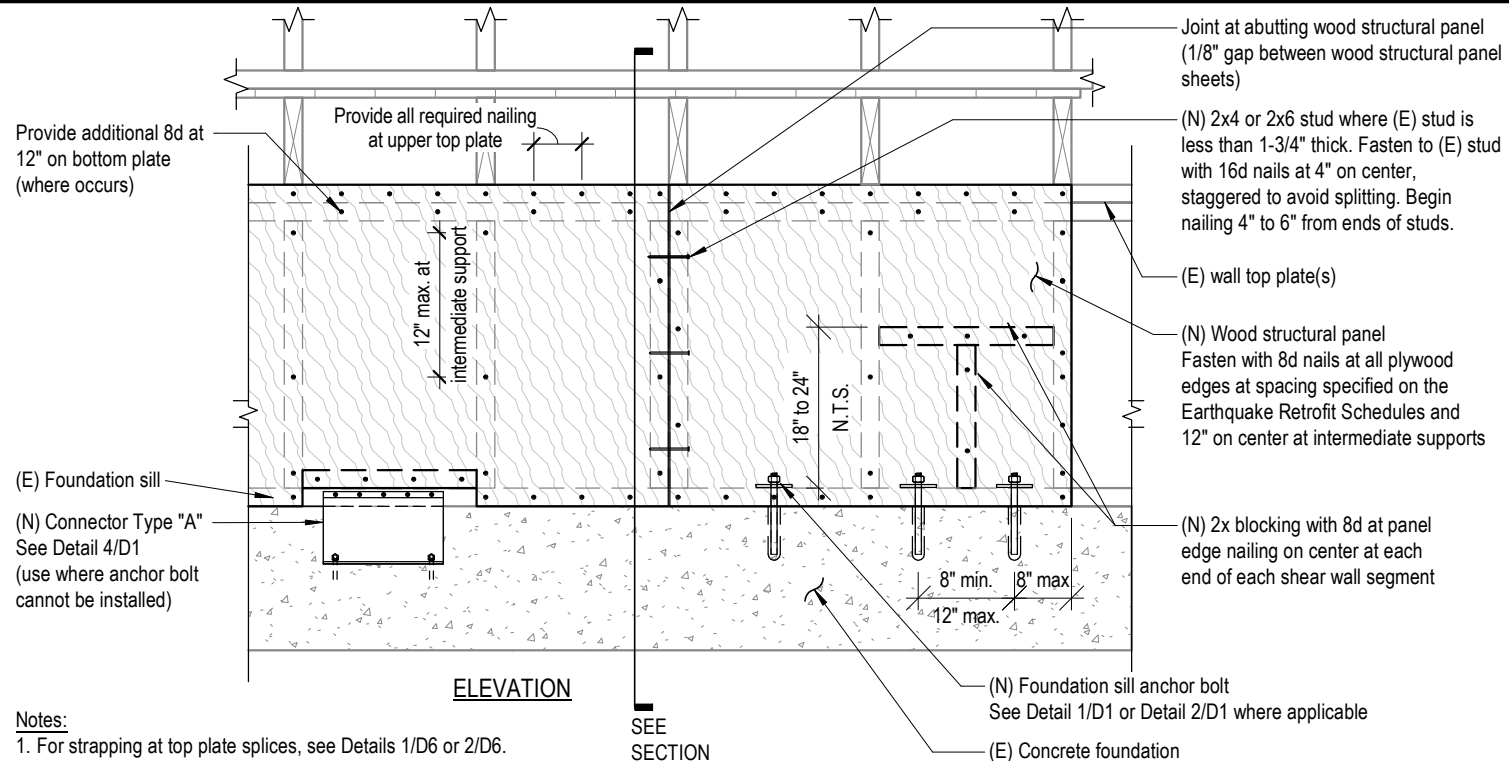
Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

APPLICANT: _____
PROPERTY ADDRESS: _____

Floor Framing to Wall Connection Details

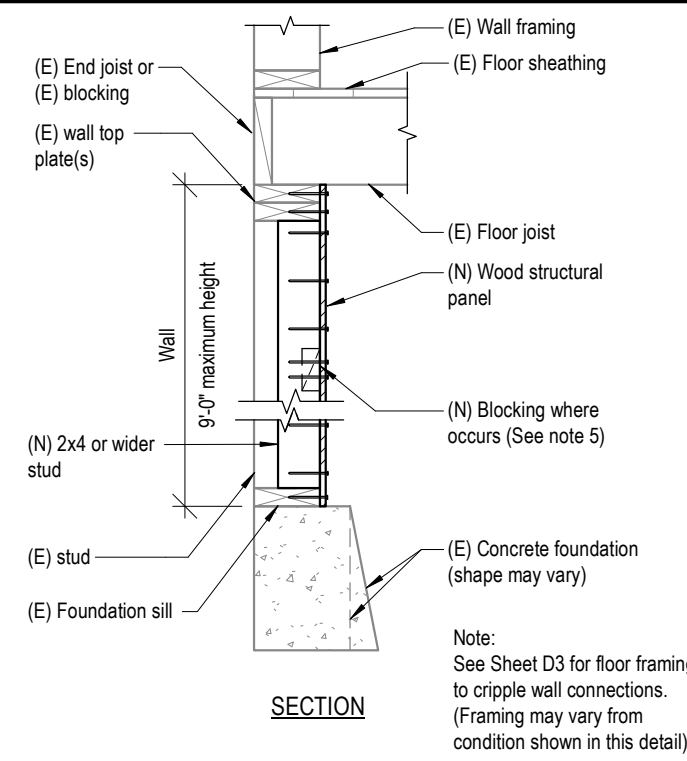
Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D3**



- Notes:
1. For strapping at top plate splices, see Details 1/D6 or 2/D6.
 2. At vents or similar wall blockouts, see Detail 3/D6.
 3. Prior to installing wood structural panels, see Detail 4/D6 where pipes or conduits pass through studs or top plates.
 4. Wood structural panels may be installed vertically (face grain parallel to stud) or horizontally.
 5. Provide 2x4 flat blocking at all horizontal panel edges.

1 FOUNDATION SILL SAME WIDTH AS WALL



MATERIAL KEY:

Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

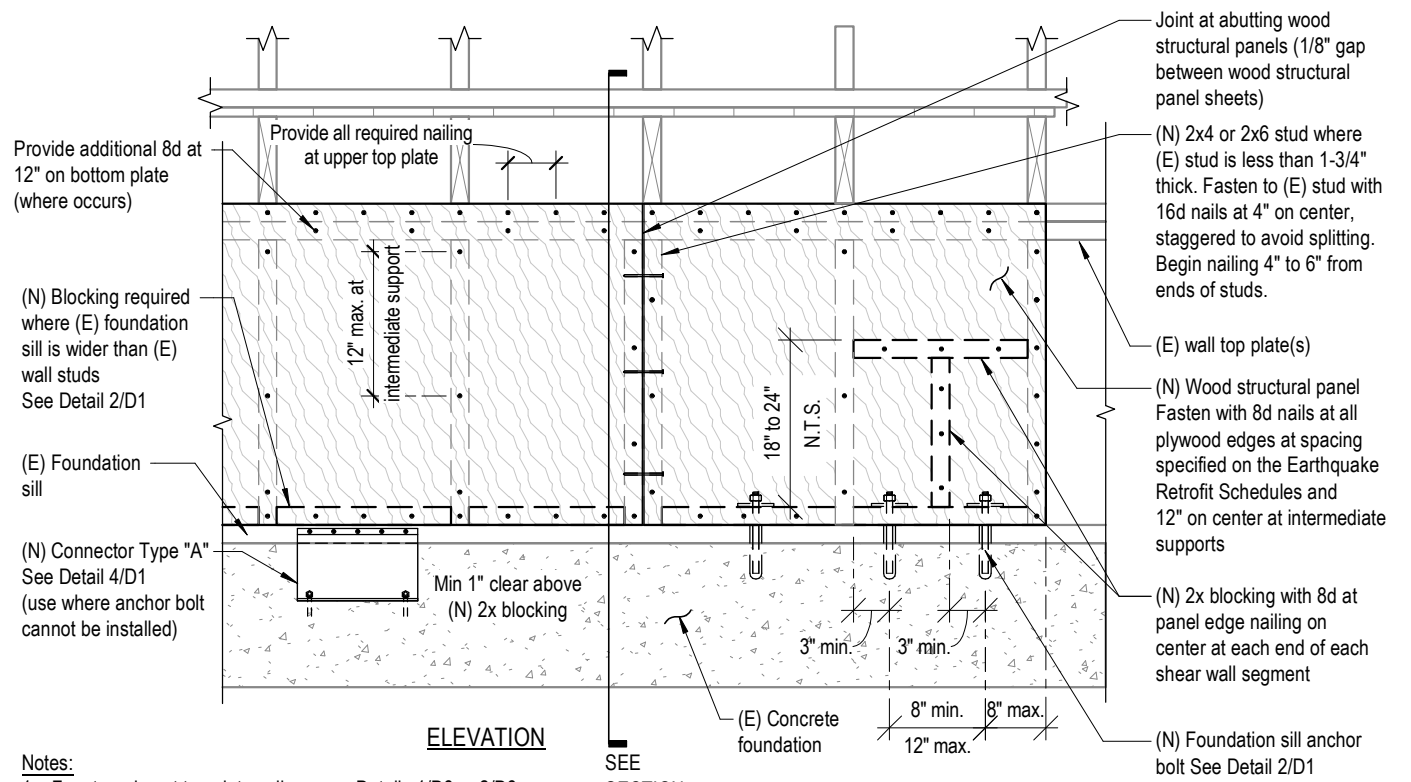
Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing. Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	[Redacted]
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	[Redacted]

For Connector types see Sheet S3.

APPLICANT: _____
 PROPERTY ADDRESS: _____

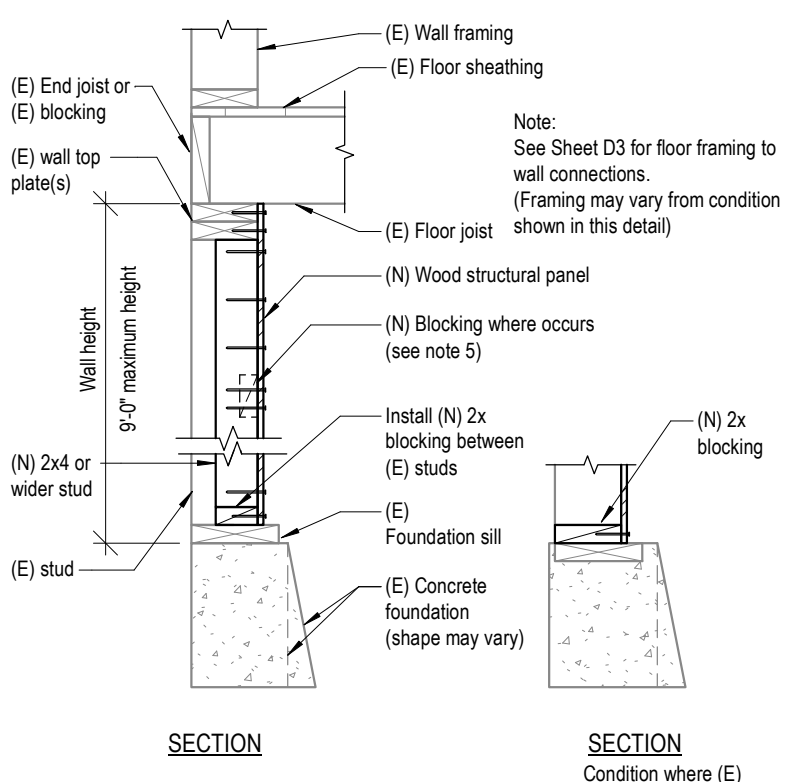
Wood Structural Panel Installation at Shear Walls without Tie-Downs

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings



- Notes:
1. For strapping at top plate splices, see Details 1/D6 or 2/D6.
 2. At crawlspace vents or similar cripple-wall blockouts, see Detail 3/D6.
 3. Prior to installing wood structural panels, see Detail 4/D6 where pipes or conduits pass through studs or top plates.
 4. Wood structural panels may be installed vertically (face grain parallel to stud) or horizontally.
 5. Provide 2x4 flat blocking at all horizontal panel edges.

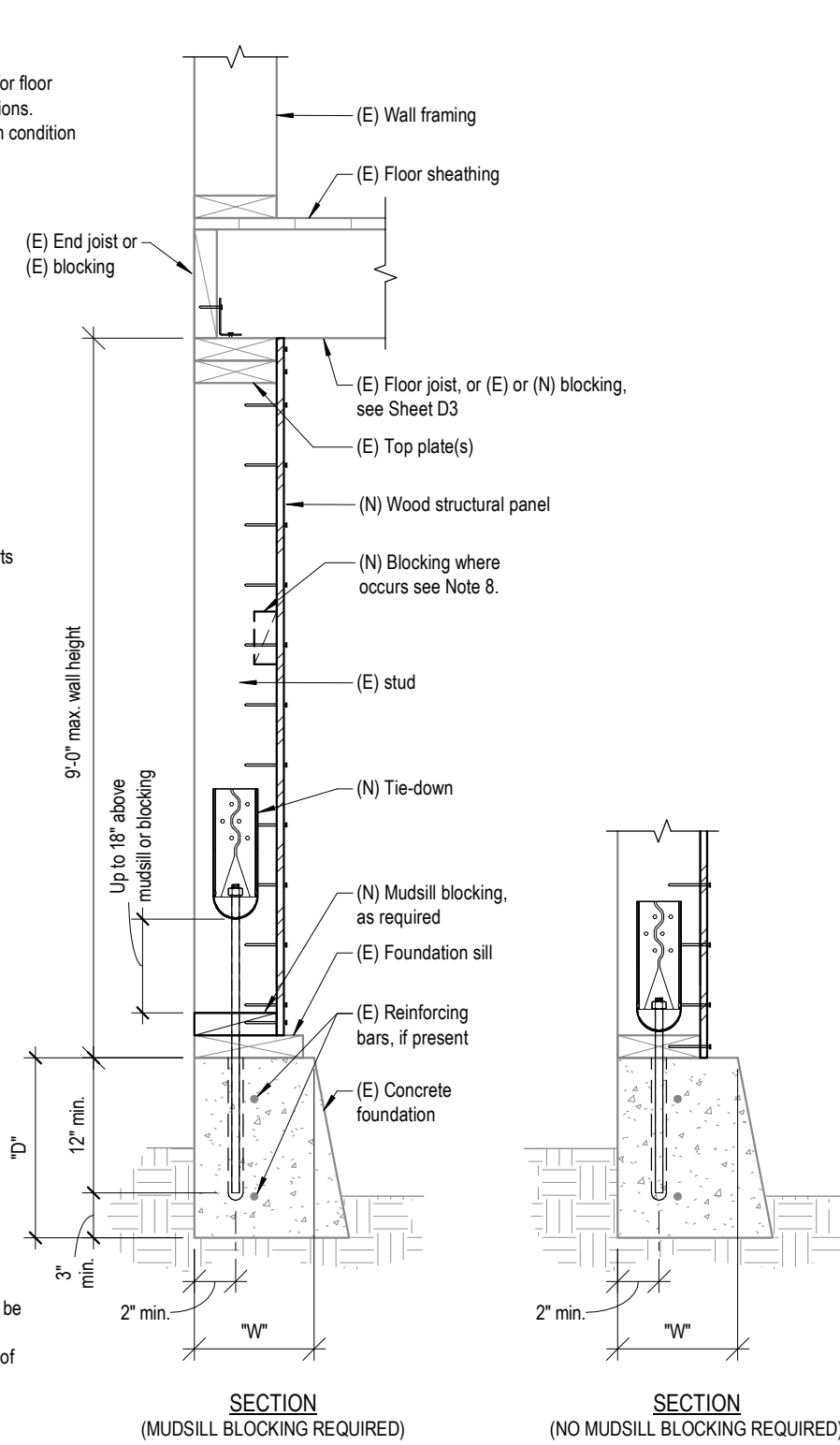
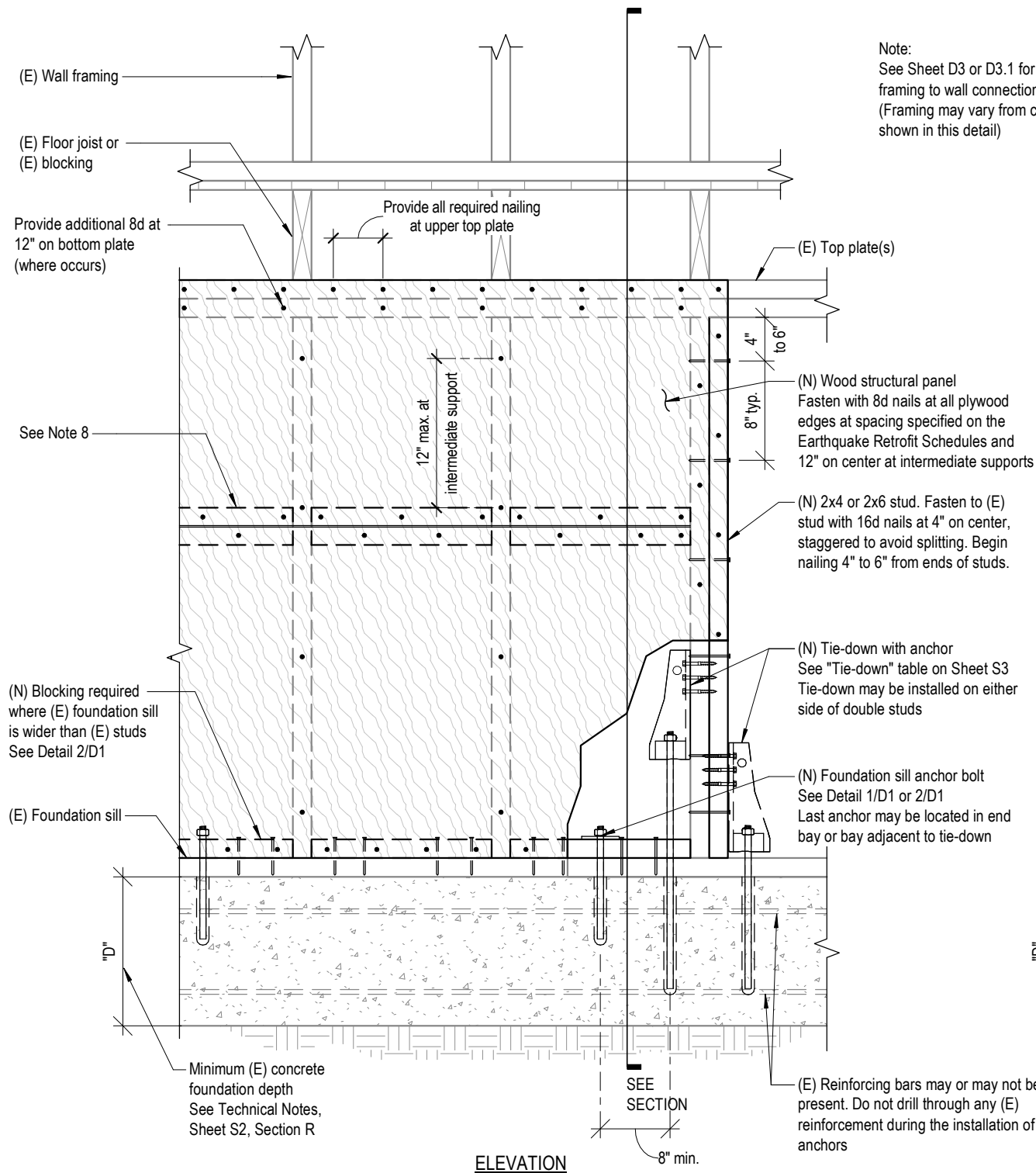
2 FOUNDATION SILL WIDER THAN WALL



ABBREVIATIONS

Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

Date: _____
 Sheet: **D4**



- Notes:**
1. For strapping at top plate splices, see Details 1/D6 or 2/D6.
 2. At vents or similar wall blockouts, see Detail 3/D6.
 3. Prior to installing wood structural panels, see Detail 4/D6 where pipes or conduits pass through cripple studs or top plates.
 4. "W" indicates the width of an existing foundation, or new foundation constructed in accordance with Detail 1/D7.
 5. "D" indicates the depth of an existing foundation, or new foundation constructed in accordance with Detail 1/D7.
 6. For existing foundations, see Sheet S2, Section R for additional requirements.
 7. Wood structural panels may be installed vertically (face grain parallel to stud) or horizontally.
 8. Provide 2x4 flat blocking at all horizontal panel edges.

1 TYPICAL TIE-DOWN INSTALLATION

MATERIAL KEY:

Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	

For Connector types see Sheet S3.

ABBREVIATIONS

Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

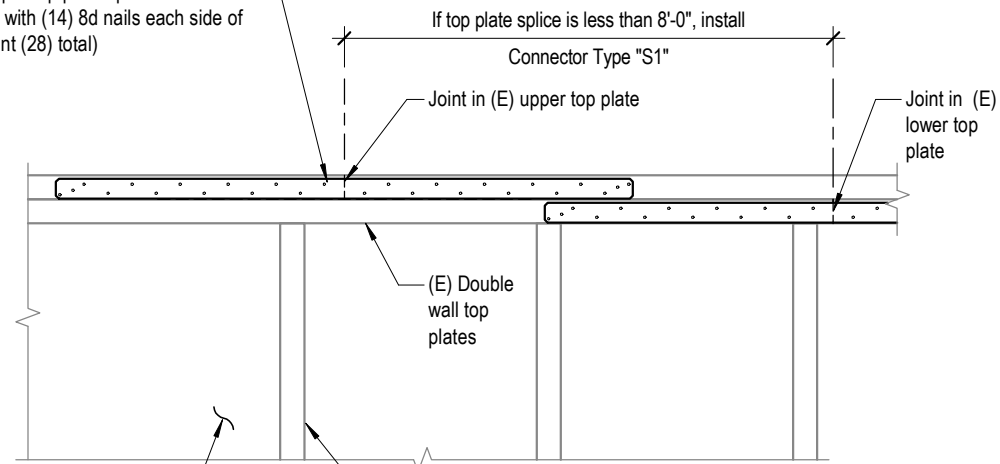
APPLICANT: _____
PROPERTY ADDRESS: _____

Wood Structural Panels with Tie-Downs

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D5**

(N) Connector Type "S1" centered at (E) upper top plate splice location
Install with (14) 8d nails each side of the joint (28) total



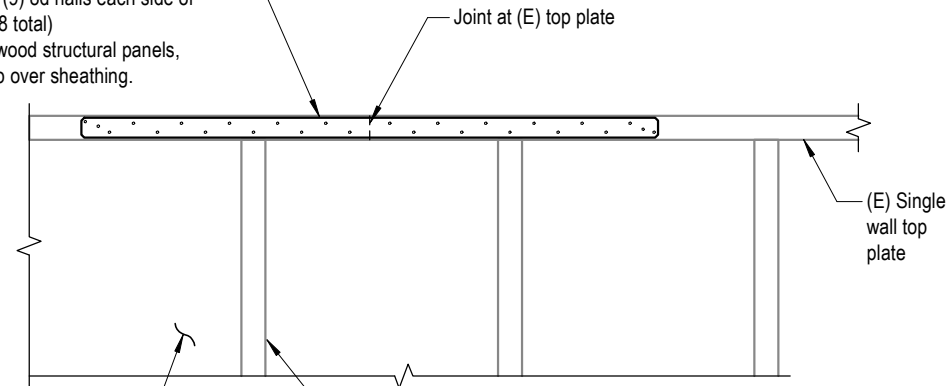
(N) Wood structural panel, where required
Detail 1/D5, 1/D4 or 2/D4 for installation
(Panel not shown)

(E) wall stud

Notes:
1. Floor framing not shown for clarity.
2. In area of wood structural panels, install strap over sheathing.

1 TOP PLATE SPLICE AT EXISTING DOUBLE TOP PLATES

(N) Connector Type "S1" centered at (E) top plate splice location
Install with (9) 8d nails each side of the joint (18) total
In area of wood structural panels, install strap over sheathing.

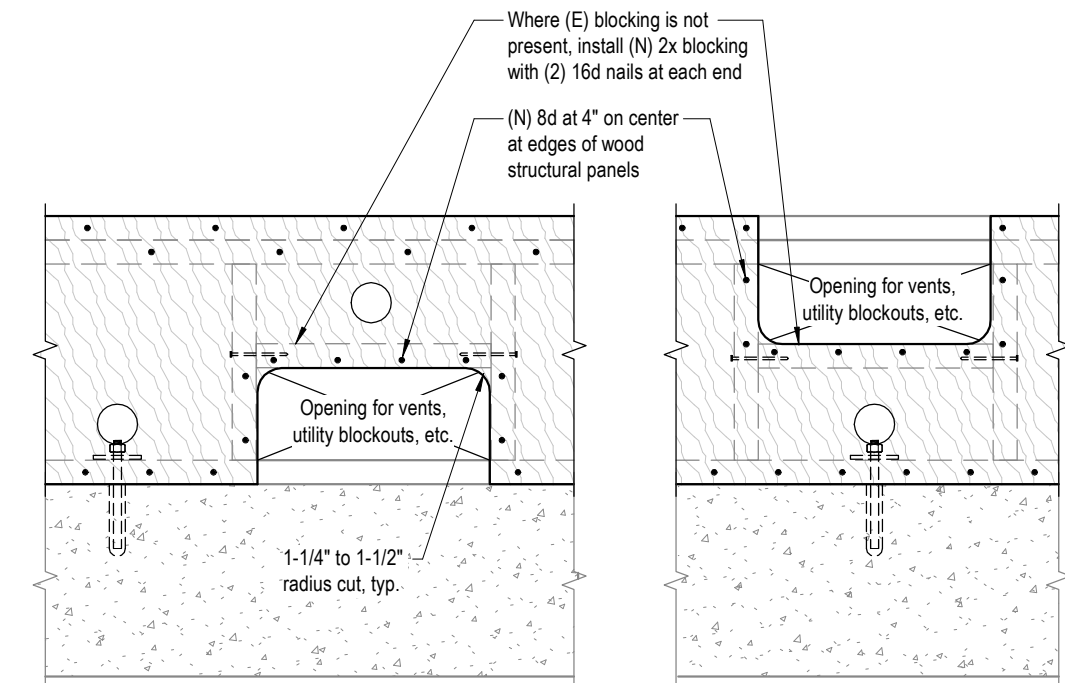


(N) Wood structural panel, where required
Detail 1/D5 or 2/D5 for installation
(Panel not shown)

(E) wall stud

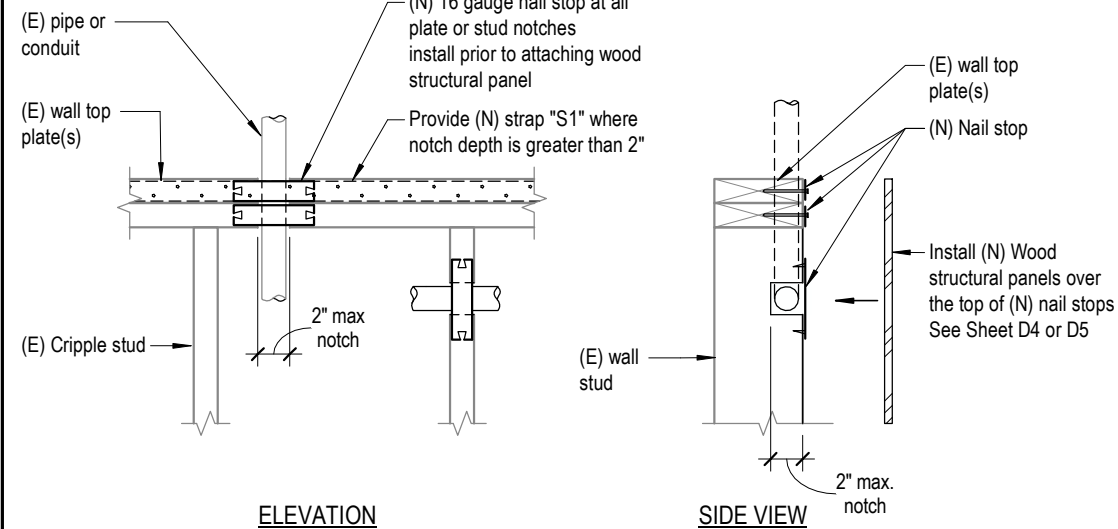
Notes:
1. Floor framing not shown for clarity.
2. In area of wood structural panels, install strap over sheathing.

2 TOP PLATE SPLICE AT EXISTING SINGLE TOP PLATE



Notes:
1. Do not cover existing vents.
2. Increase wood structural panel length a distance equal to the length of blockout(s) or one stud bay width whichever is greater.

3 CUTOUT REQUIREMENTS IN WOOD STRUCTURAL PANELS



Note:
Floor framing not shown.

4 ALLOWABLE NOTCHING AND REINFORCING FOR TOP PLATES AND STUDS

MATERIAL KEY:	
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:	
Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing. Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	
For Connector types see Sheet S3.	

ABBREVIATIONS

Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

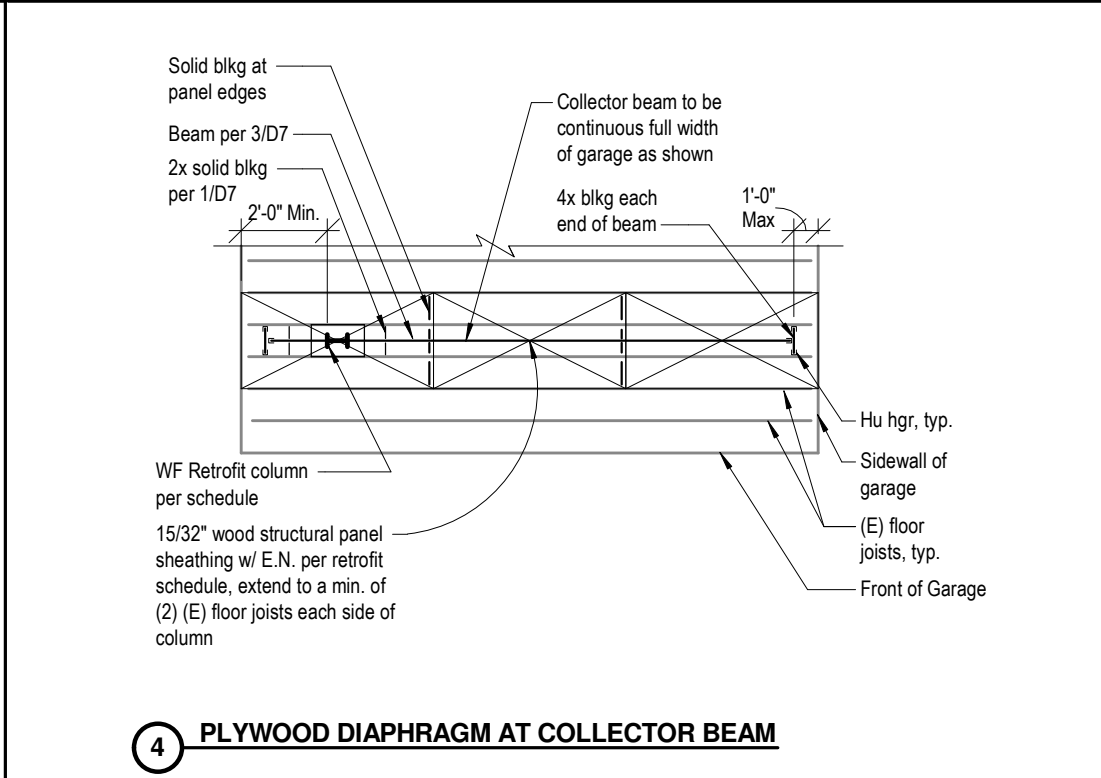
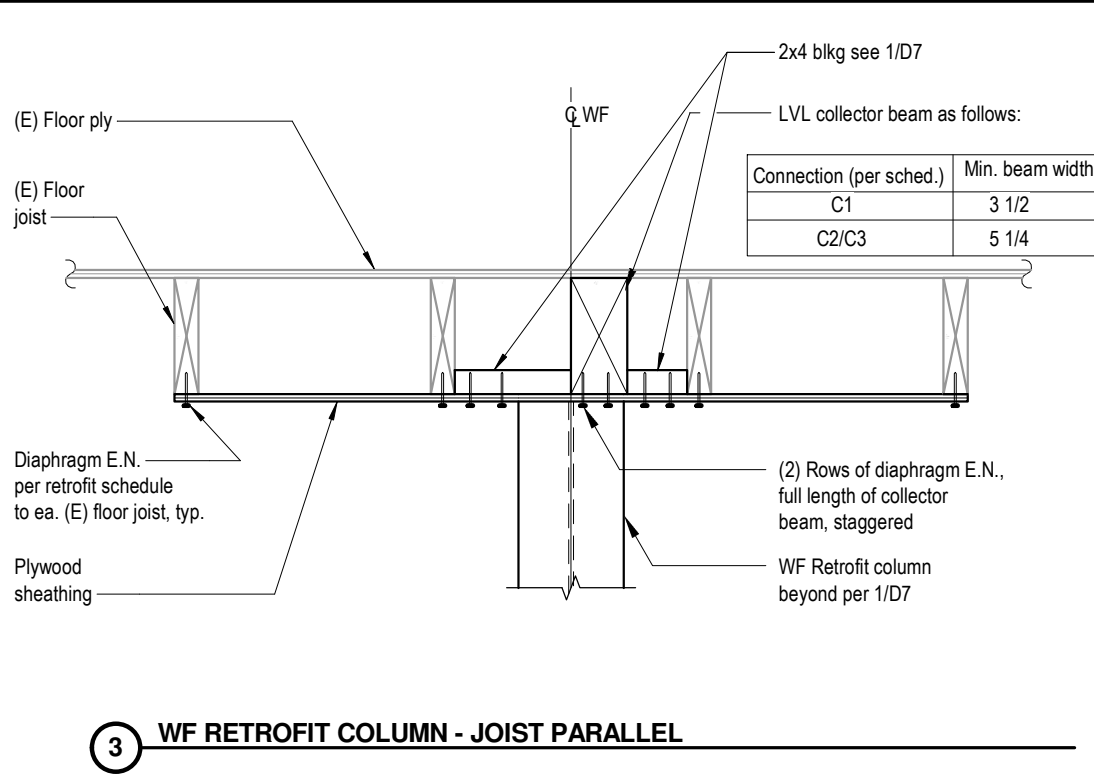
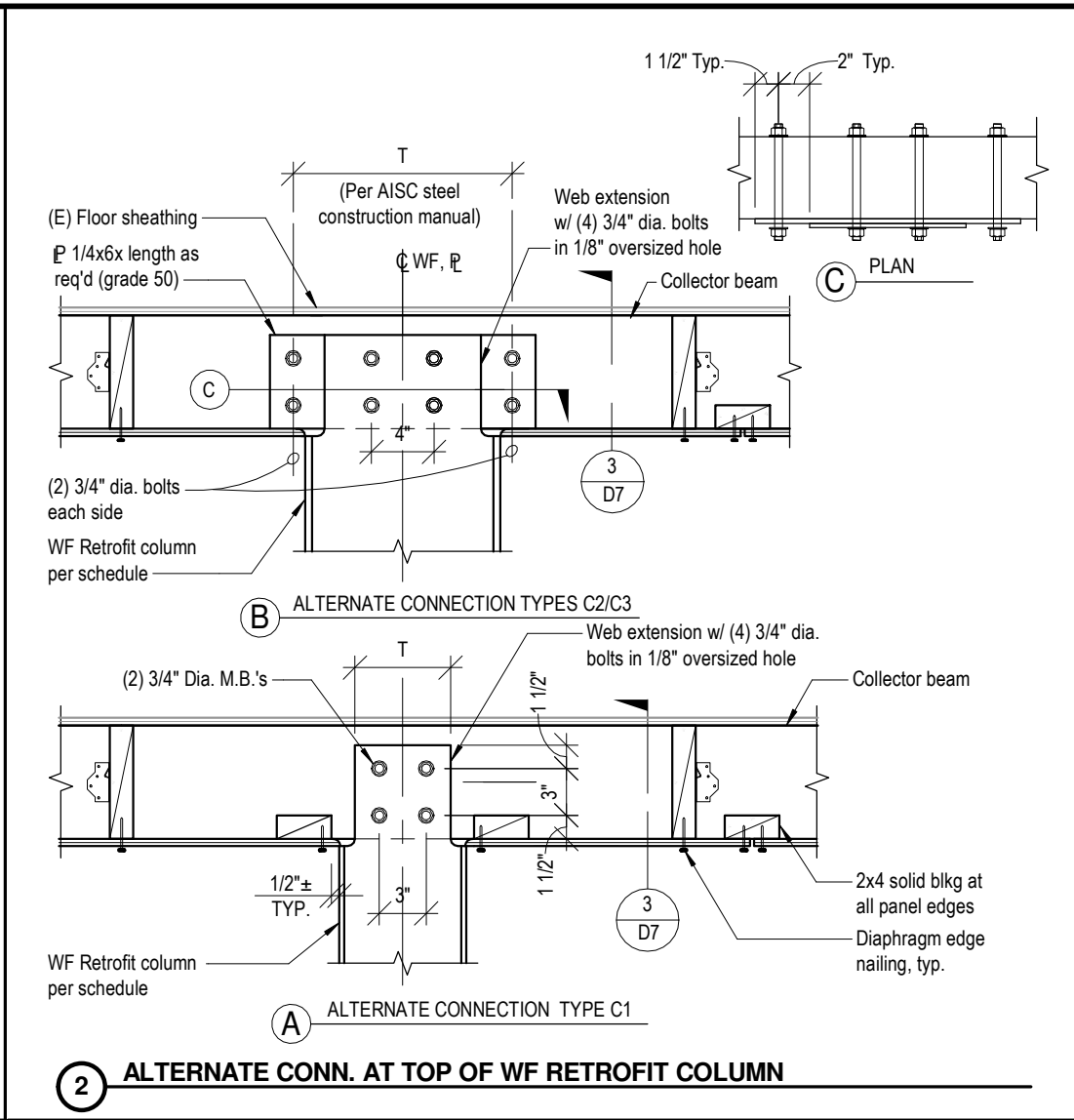
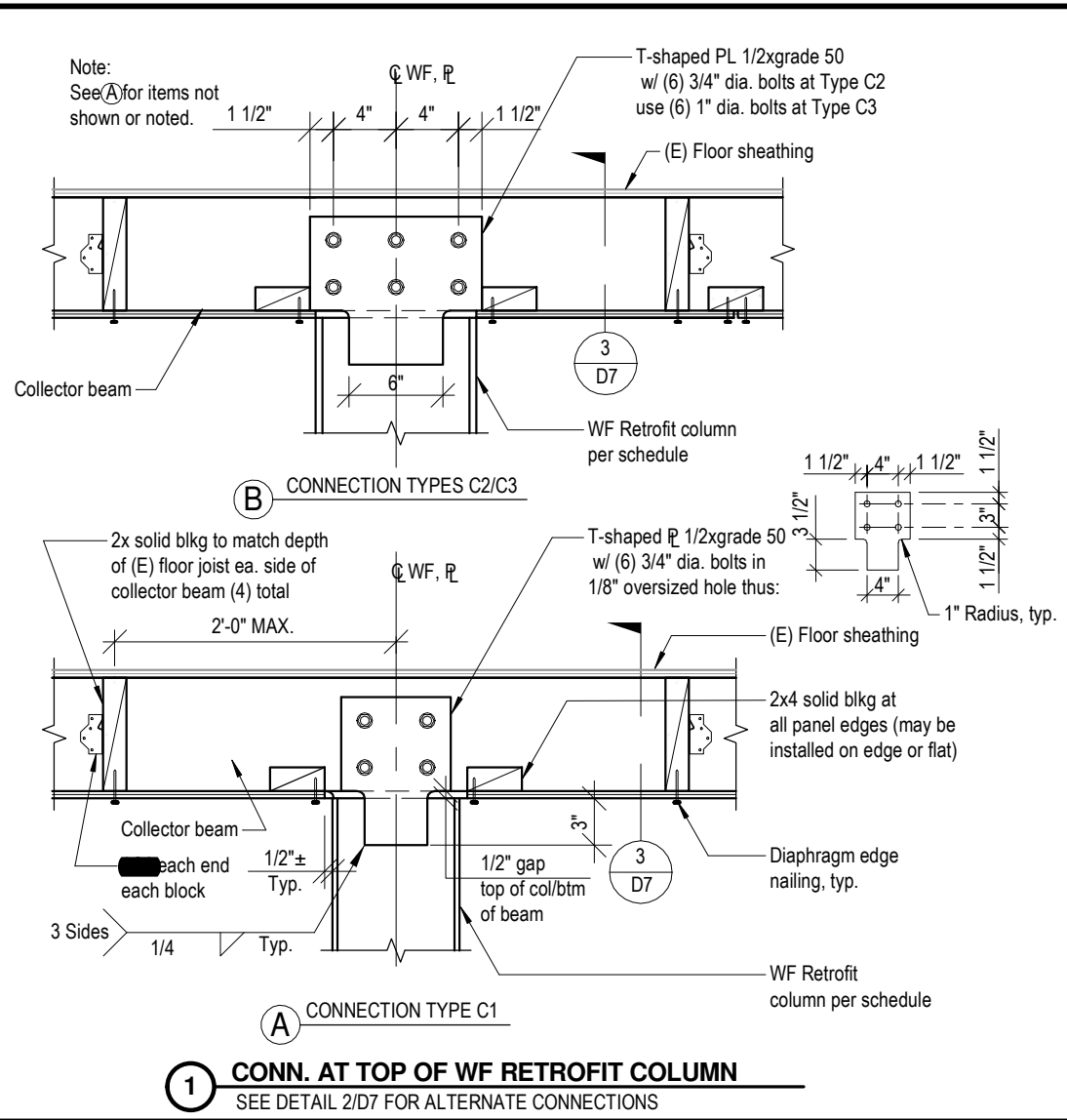
APPLICANT: _____
PROPERTY ADDRESS: _____

Vent Openings and Top Plate Details

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____



MATERIAL KEY:
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	

For Connector types see Sheet S3.

ABBREVIATIONS

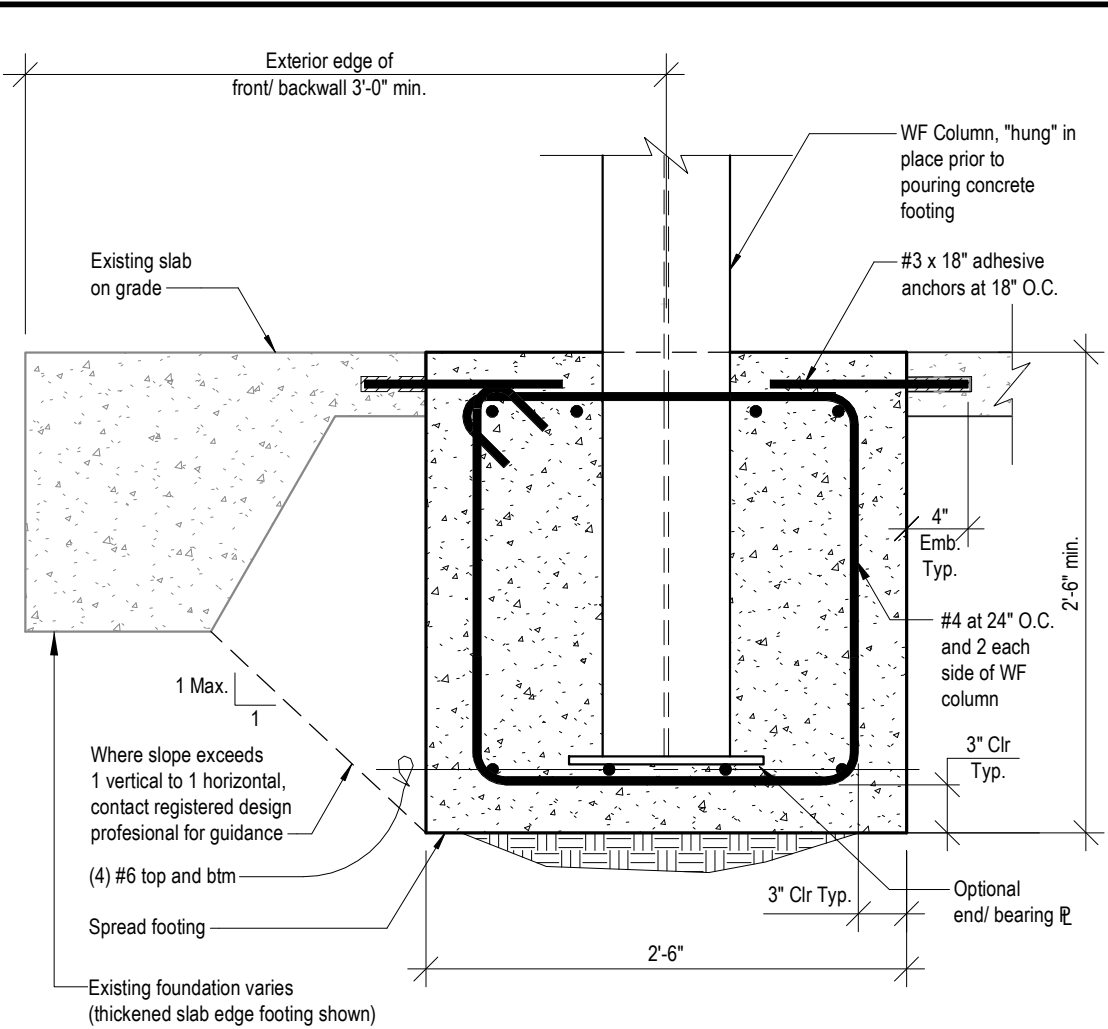
Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

APPLICANT: _____
PROPERTY ADDRESS: _____

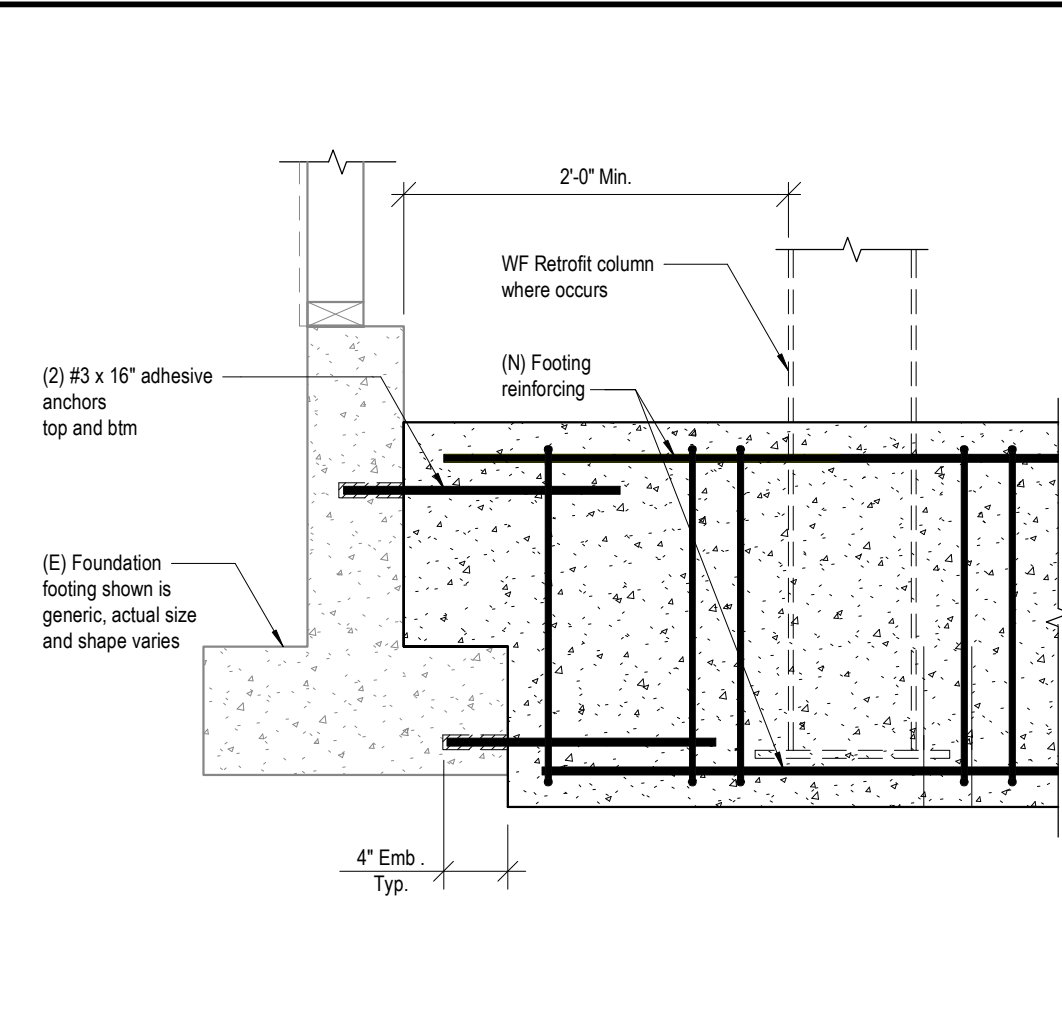
Structural Details at Steel Retrofit Column

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D7**



1 FOOTING AT NEW RETROFIT COLUMN



2 TIES FROM NEW TO EXISTING FOUNDATION

MATERIAL KEY:
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	[Redacted]
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	[Redacted]

For Connector types see Sheet S3.

ABBREVIATIONS

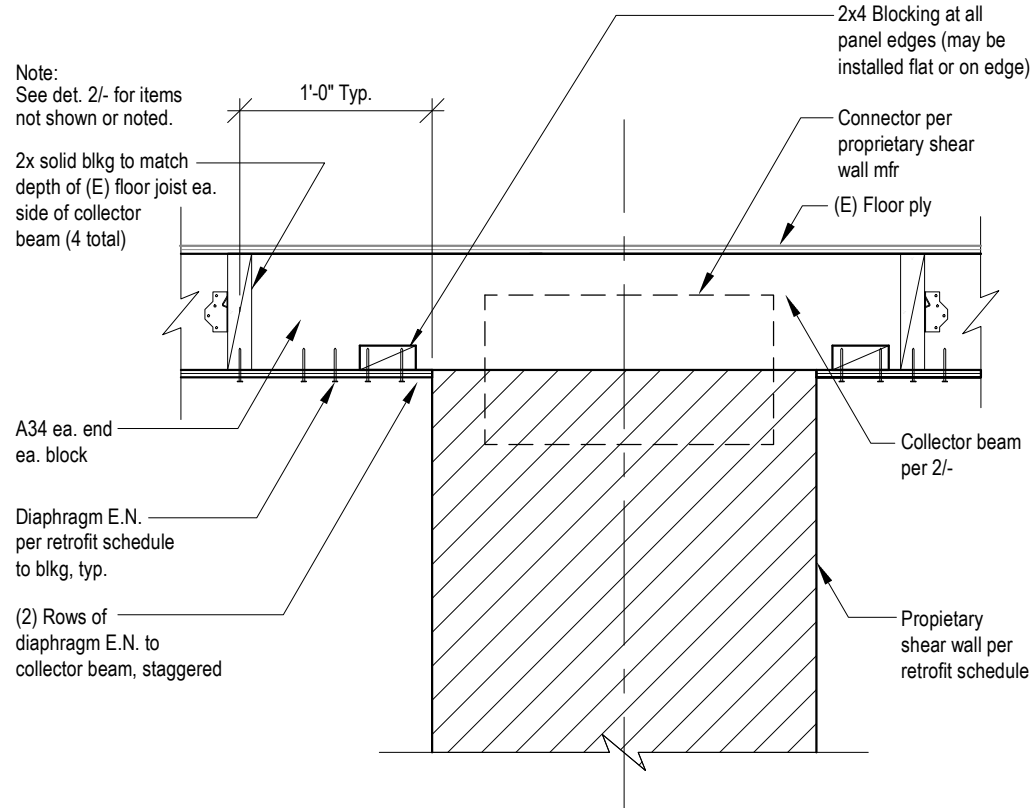
Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

APPLICANT: _____
PROPERTY ADDRESS: _____

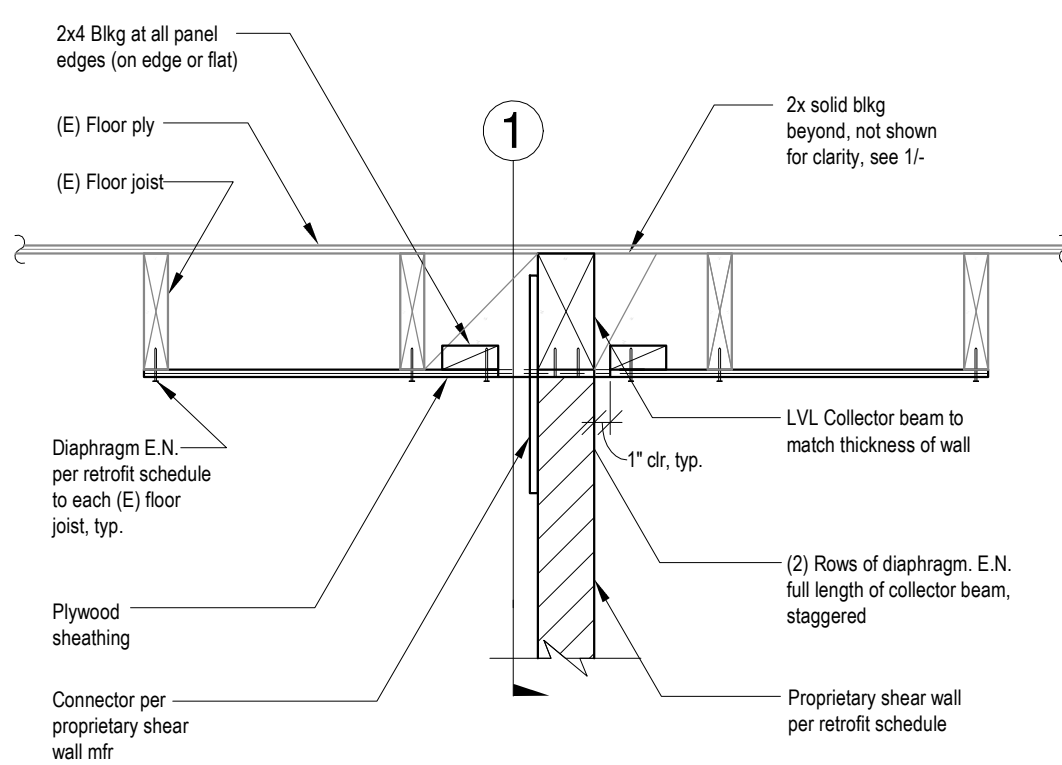
Foundation Details at Steel Retrofit Column

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D7.1**



**1 FLOOR CONN. AT PROPRIETARY SHEAR WALL
FLOOR FRAMING PARALLEL TO GARAGE FRONT**



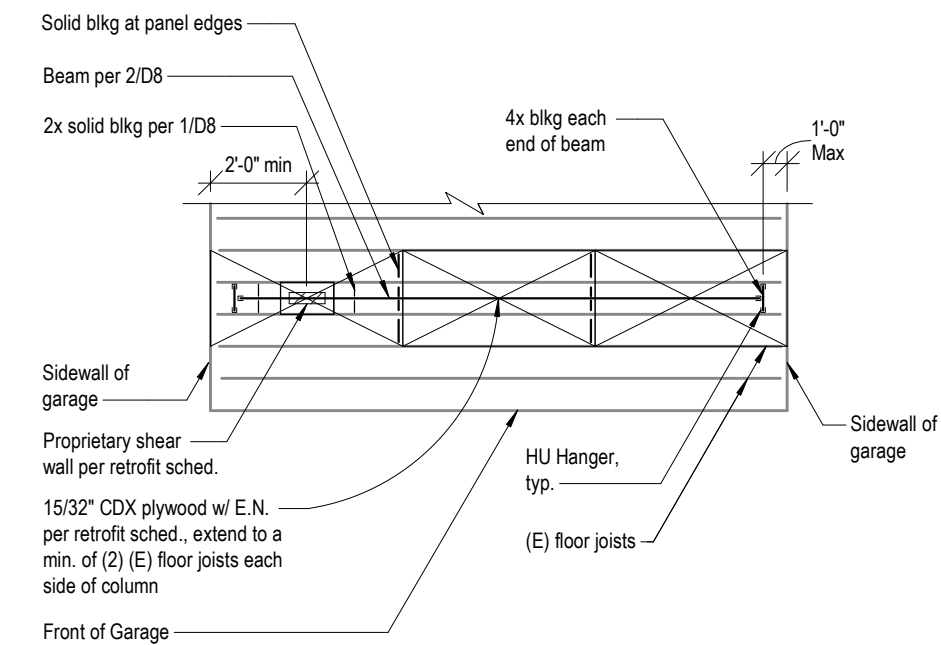
**2 FLOOR CONN. AT PROPRIETARY SHEAR WALL
FLOOR FRAMING PARALLEL TO GARAGE FRONT**

MATERIAL KEY:
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	[REDACTED]
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	[REDACTED]

ABBREVIATIONS

Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

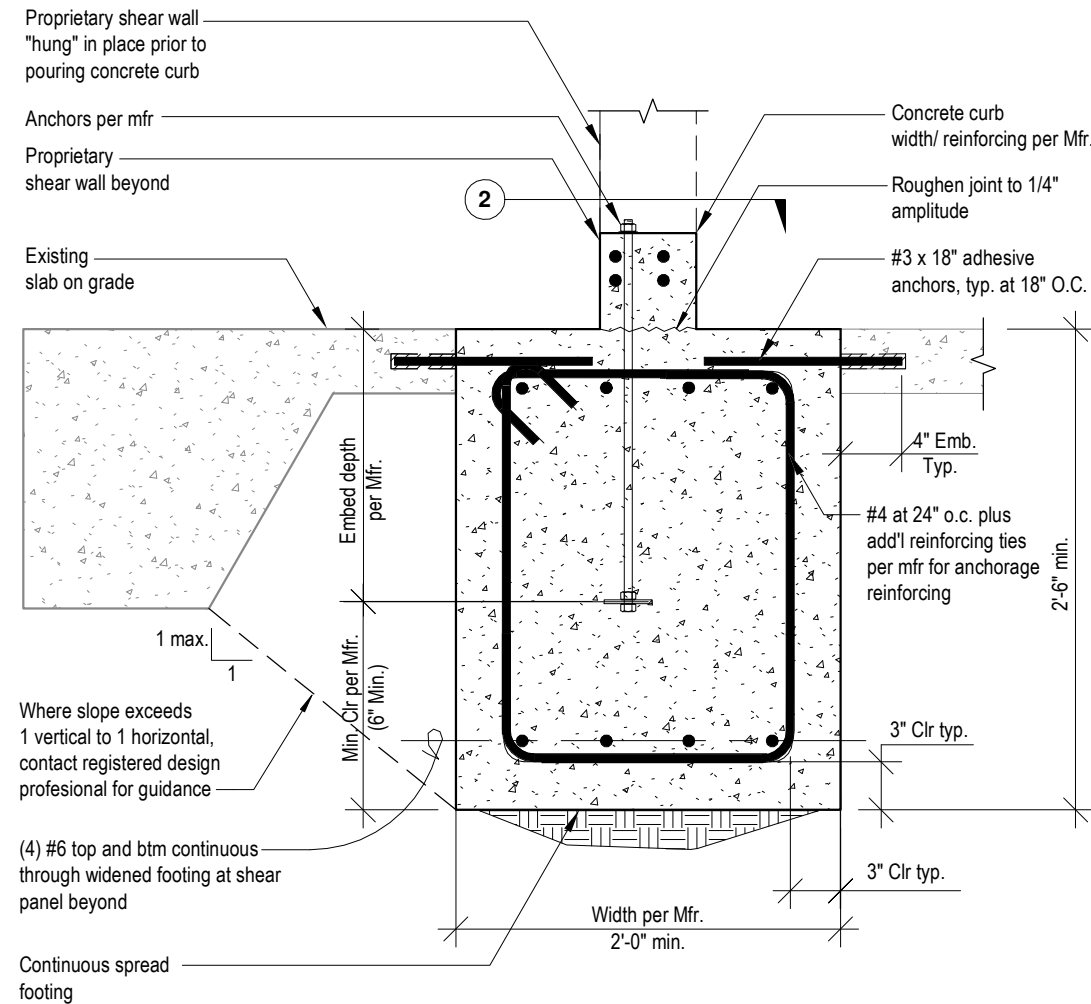


**3 PLYWOOD CEILING SOFFIT DIAPHRAGM AT COLLECTOR BEAM
PLAN VIEW AT CEILING**

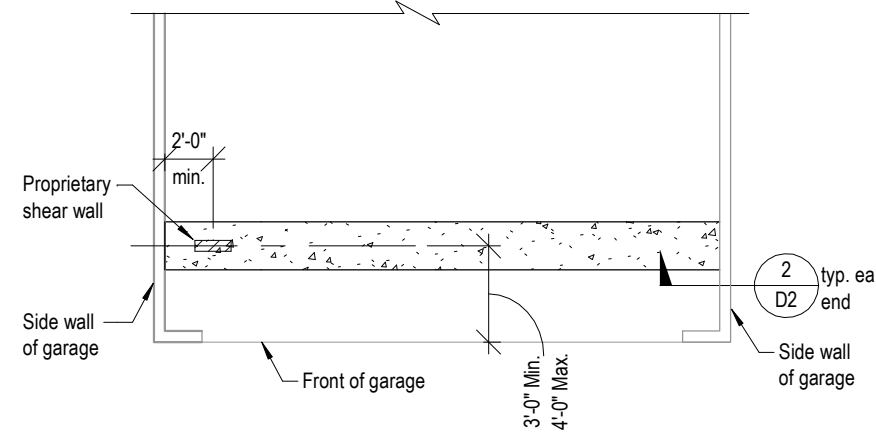
APPLICANT: _____
PROPERTY ADDRESS: _____

Structural Details at Proprietary Shear Wall Retrofit
Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D8**



1 CONT. FOOTING/ GRADE BEAM AT PROPRIETARY



2 PLAN VIEW AT FOUNDATION

MATERIAL KEY:

Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long

Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw

Wood Structural Panel	15/32" Wood Structural Panel-Sheathing, Exposure 1, 5-Ply.
-----------------------	--

LVL (Laminated Veneer Lumber)	
-------------------------------	--

Plate Washer	3" x 3" square x 0.229" thick.
--------------	--------------------------------

"Peel & Stick" Flashing Tape	
------------------------------	--

For Connector types see Sheet S3.

ABBREVIATIONS

Clr.	Clearance
Conc.	Concrete
Dia.	Diameter
(E)	Existing
EQ.	Equal
E.N.	Edge Nail
Emb.	Embedment
(N)	New
Max.	Maximum
Min.	Minimum
Mfr.	Manufacturer
N.T.S.	Not to Scale
O.C.	On Center
PL	Plate
S.O.G.	Slab on ground
Typ.	Typical
w/	with

APPLICANT: _____
PROPERTY ADDRESS: _____

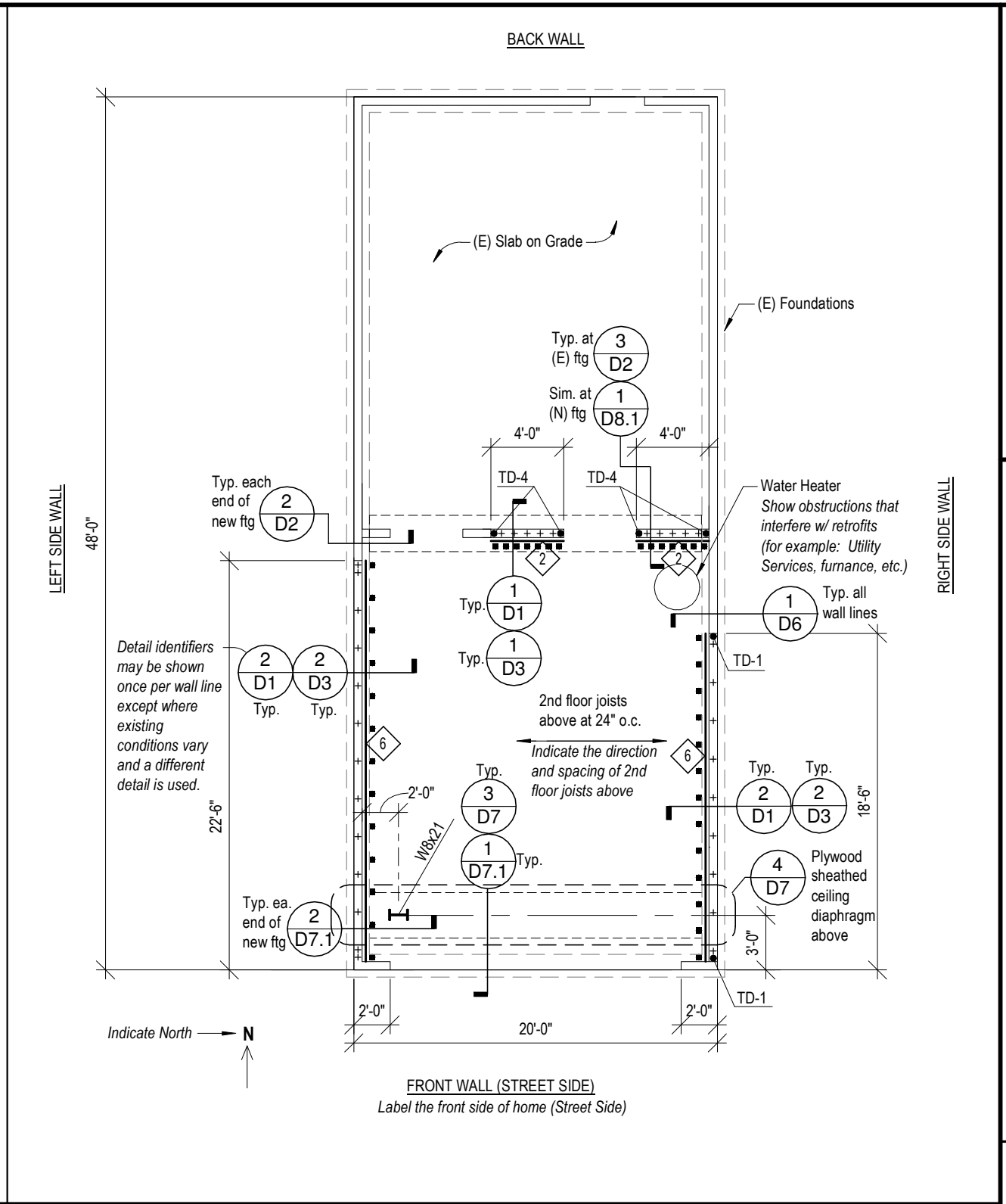
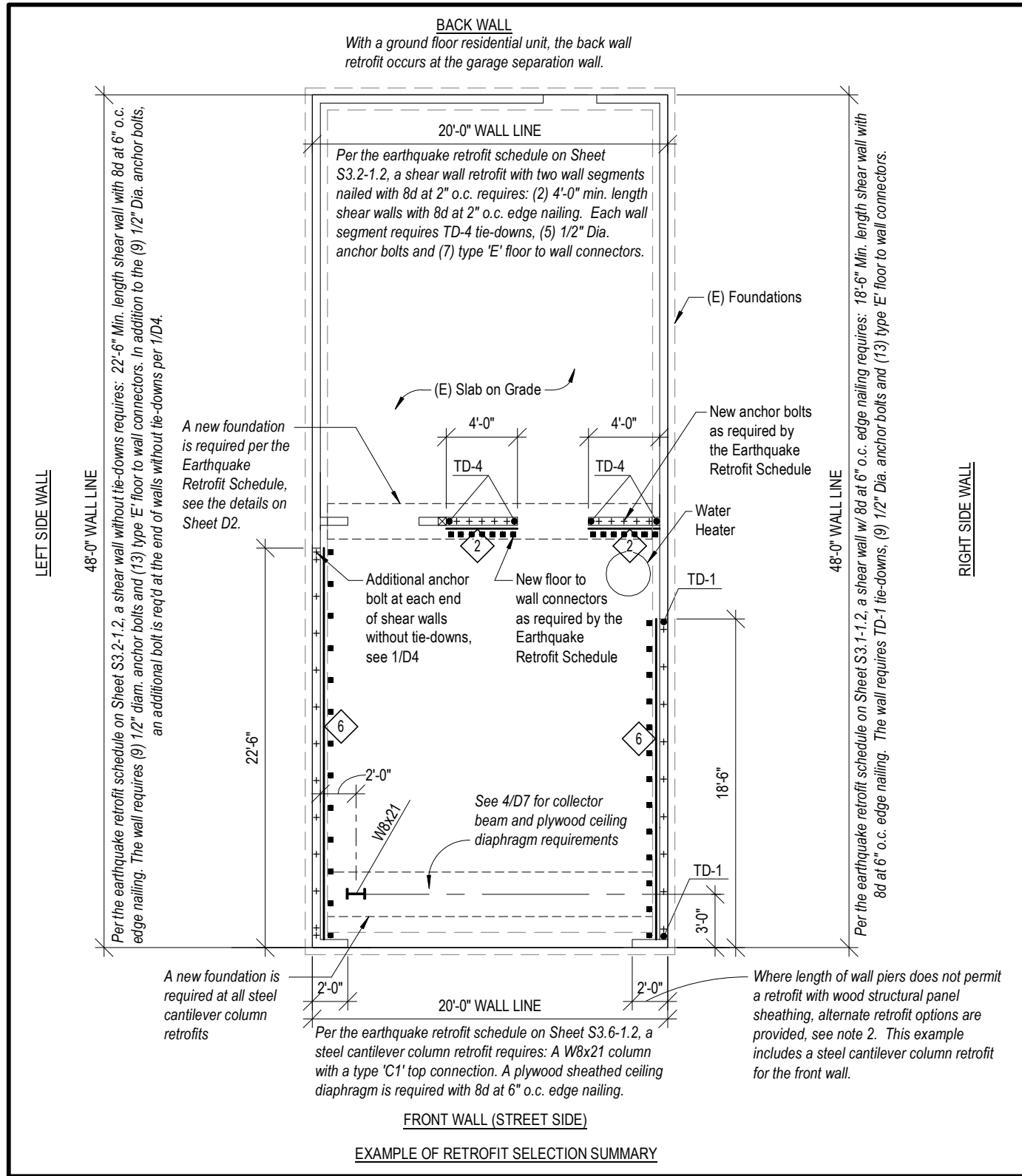
Foundation Details at Proprietary Shear Wall Retrofit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

D8.1



NOTES:

1. Plan shows typical notation. Instructional notes are in *italics* and should not be included on submittal drawing. Refer to Sheet 01 for additional instructions.

2. This example illustrates potential retrofit options selected from the provided Earthquake Retrofit Schedules. There are multiple options that are applicable to a building of this size and weight that are not shown.

Key:

Retrofit shear wall edge nail spacing per the Earthquake Retrofit Schedule. # denotes the edge nail spacing.

+ Foundation sill anchor bolt or connector

■ Floor to wall framing connector

TD-# Tie-down. # denotes the tie down size per schedule, see sheet S3.

Definitions:

(E) Existing

(N) New

Wall line: All wall segments forming the overall building dimensions on one side

This example includes a house qualifying as a Living-Space-Over-Garage Dwelling with a Ground Floor Residential unit. The following parameters apply:

960 square foot home
"Light" weight classification
S_{DS} = 1.2 (located in SDC D)

- The front wall retrofit is selected from the Earthquake Retrofit Schedule on Sheet S3.6-1.2, using a steel cantilever column. A steel column was selected due to the limited length of the wall piers at the front of the garage.
- The side wall retrofits are selected from the schedule on Sheet S3.1-1.2. The left side is free of obstructions, so a long shear wall retrofit not requiring tie-downs is used. The right side wall is retrofitted with a shorter length wall with tie-downs due to the location of the water heater. The back of garage separation wall includes multiple door openings, so a double shear wall retrofit option was selected from the schedule on Sheet S3.2-1.2.

APPLICANT: _____
PROPERTY ADDRESS: _____

Example - Living-Space-Over-Garage Dwelling with a wood structural panel shearwall & cantilever column retrofit

Retrofit of Living-Space-Over-Garage Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: _____

A. Before you begin:

1. This Plan Set is intended for use by a general contractor or homeowner without necessarily having to involve a Registered Design Professional.
2. Contact your local Building Official, often known as the Building Department, to understand the building permit application process.
Inquire about:
 - a. fees,
 - b. how many copies of the plans must be submitted, and
 - c. which city inspections are required, see F.3 below.
3. The Building Official may also be able to assist with assessing the applicability of this plan set to a home. See Eligibility For Use, Sheet S0.
4. Complete the Eligibility For Use questionnaire on Sheet S0 (Table 1), to determine if this plan set is applicable. A "non-compliant" answer to any question disqualifies the home from using this plan set, unless a Registered Design Professional is involved.

B. Determine your Seismic Design Category (SDC) and Weight Classification:

1. See Sheet S3 and determine the Seismic Design Category (SDC) and Weight Classification for the dwelling. This information will be used to determine which S3.1 sheet is applicable. Note that there are three unique S3.1 sheets for one-story dwellings with differing S_{DS} values and three similar sheets for two-story dwellings. Only one Sheet S3.1 will be applicable to any given dwelling and included within the set of drawings used for submission to the Building Official.

C. Prepare your plans:

1. Draw a scaled plan of the perimeter of the home in the graph layout area provided on Sheet S4, Foundation and Retrofit Layout Plan. Your plan should include the following:
 - a. The location of any obstructions along the perimeter of the foundation that make the retrofitting work difficult or impossible such as fireplaces, water heaters, or utilities. These areas should be avoided when laying out the required retrofitting work.
 - b. An arrow to indicate the direction of the span of your floor joists plus the spacing such as "floor joists at 16" on center." This will be helpful when selecting the appropriate details shown on Sheets D1 - D6.
 - c. Indicate the height of the tallest cripple wall for each wall line. The minimum required length of retrofitting along each wall line will be based, among other variables, on this height. See the sections in Details 1 and 2 on Sheet D4 for measurement of "cripple wall height."
 - d. Dimensions for each length of perimeter wall segment and overall dimensions of wall lines.
 - e. An arrow pointing to North.
 - f. Label the street side (front) of the home.
 - g. See Sheet X1 for an example of a plan sheet submittal.
 - h. See Sheets X2 and X3 for additional examples and instructions of how certain items are calculated, such as the length of bracing at offset walls of non-rectangular "T" or "L" shaped dwellings, as noted in Section J, General Notes, Sheet S1.
 - i. See Sheets X4 and X5 for illustrations and definitions of terms for retrofit conditions.

D. Gather information to complete the plans:

1. Review Sheets S1 and S2 for guidance on materials and installation for the required work.
2. Review the Detail Sheets included in this plan set (Sheets D1-D7). Locate the details that most substantially match the home's framing conditions. Not all details or sheets will apply. As a minimum, you should have one detail each for:
 - a. The foundation sill to concrete foundation connection (Sheet D1); and
 - b. The floor framing to foundation sill connection (Sheet D2); or
 - c. Floor framing to cripple wall connection (Sheet D3 and/or Sheet D3.1).
3. Differences in existing conditions from those illustrated on the details that result in changes to these drawings will need to be reviewed by a Registered Design Professional. See "Purpose" on Sheet S0 for additional information.
4. Once you have chosen the correct (applicable) S3.1 sheet, follow the instructions provided to determine the amount and type of earthquake retrofitting required along each perimeter wall line. Once Steps 1 through 7 of the instructions are completed, document the results within the Retrofit Table as explained in Step 8.
5. Refer to Supplemental Technical Notes on Sheet S2 where tie-downs are required.

E. Complete your plans:

1. Using the information from the Earthquake Retrofit Schedule on Sheet S3.1, add the following to complete your Foundation and Retrofit Layout Plan on Sheet S4:
 - a. Indicate and dimension the total length of braced wall sections required at each wall line.
 - b. Identify the details used for the connections as noted in D.2 above. Indicate the connection type and the minimum number of connectors for each wall line. Conform to Sections L and M of Sheet S1.
 - c. Identify the details used for the wood structural panel (Sheets D4 or D5).
 - d. If tie-downs are used, identify the details used (Sheet D5).
 - e. Identify the detail used for the top plate splice (Sheet D6).
 - f. Identify the details used for notching and/or cutouts (Sheet D6.)

F. Submit your plans:

1. Submit a permit application and the required number of completed sheets (Sheets S0 through D7) to the Building Official for review. Photographs of the foundation sill, cripple wall, and floor framing conditions may assist the review process.
2. Before starting work, the permit holder may be required to schedule a preconstruction inspection with the Building Official to verify that field conditions are consistent with the information provided on the approved plan.
3. Inspection(s) by the Building Official may be required for:
 - a. Foundation Anchor bolts / Anchor Plate installation,
 - b. Blocking installation,
 - c. Wood structural panel on cripple wall, sheathing and nailing,
 - d. Metal hardware "connectors" installation,
 - e. Tie-downs, and
 - f. Final inspection.

SHEET LIST

01*	Instructions for Use
S0	Cover Sheet
S1	General Notes
S2	Supplemental Technical Notes
S3	Seismic Design Category, Weight Classification, and Connectors
S3.1**	Earthquake Retrofit Schedule - S_{DS} 1.0, One-Story
S3.1**	Earthquake Retrofit Schedule - S_{DS} 1.2, One-Story
S3.1**	Earthquake Retrofit Schedule - S_{DS} 1.5, One-Story
S3.1**	Earthquake Retrofit Schedule - S_{DS} 1.0, Two-Story
S3.1**	Earthquake Retrofit Schedule - S_{DS} 1.2, Two-Story
S3.1**	Earthquake Retrofit Schedule - S_{DS} 1.5, Two-Story
S4	Foundation and Retrofit Layout Plan
D1	Foundation Sill to Concrete Foundation Connection Details
D2	Floor Framing to Foundation Sill Connection Details
D3	Floor Framing to Cripple Wall Connection Details
D3.1	Floor Framing to Cripple Wall Connection Details
D4	Wood Structural Panel Installation without Tie-Downs
D5	Wood Structural Panel Installation with Tie-Downs
D6	Vent Openings and Top Plate Details
D7	Foundation Replacement Details
X1*	Example of Foundation and Retrofit Layout Plan
X2*	Example - Foundation Plan (Dwelling without Tie-Downs)
X3*	Example - Foundation Plan (Dwelling with Tie-Downs)
X4*	Illustration - Cripple Wall Retrofit
X5*	Illustration - Retrofit - No Cripple Wall

* Sheet for reference only. Do not submit to the Building Official.

** Only one "S3.1" sheet will be submitted to the Building Official.

Instructions for Use

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of
One- and Two-Family Dwellings

SCOPE

This Plan Set contains prescriptive provisions for retrofit of wood light-frame crawlspace dwelling anchorage to the foundation and cripple walls. Dwellings shall be considered cripple wall dwellings for purposes of this plan set when:

- The dwelling has unoccupied space below the lowest framed floor.
- The dwelling has cripple walls not exceeding 7'-0" tall (Figure 1).
- The downhill slope does not exceed 20%. (Figures 2 & 3).

Where dwellings include both crawlspaces and portions of the dwelling with concrete slabs-on-grade, this Plan Set applies to the perimeter of the crawlspace portions of the dwelling. This Plan Set does not require work in the slab-on-grade portions of the dwelling. However, the user is encouraged to add additional anchor bolts, where possible, around the perimeter of the slab-on-grade portions per Sheet D1 to increase the foundation sill to existing concrete connection.

DESIGN BASIS

This Plan Set is deemed to comply with Chapter 4 . Specific design assumptions are as follows: R = 4.0; $\Omega_o = 1.5$; S_{DS} = Varies (between 1 and 1.5), Site Class C.

GENERAL

Cripple Wall Retrofit in accordance with this plan set shall include each of the following for the full extent of the crawlspace perimeter (Figure 4):

- 1 Wood structural panels in accordance with the Earthquake Retrofit Schedule, Sheet S3.1 and details on Sheets D5 & D4 at all non-zero height cripple walls, and
- 2 Foundation sill plate anchorage to the foundation in accordance with the Earthquake Retrofit Schedule, Sheet S3.1 and details on Sheets D1 & D2, and
- 3 Floor framing to cripple wall top plates or floor framing to foundation sill plate connections in accordance with the Earthquake Retrofit Schedule, Sheet S3.1 and details on Sheets D3 & D5.

Any retrofit not incorporating each applicable item at the full crawlspace perimeter shall not be identified as conforming to this Plan Set. All work shall be in accordance with Sheet S1 General Notes.

This Plan Set for strengthening is intended to be approved by the Building Official without requiring additional plans or calculations, except as required for differing conditions.

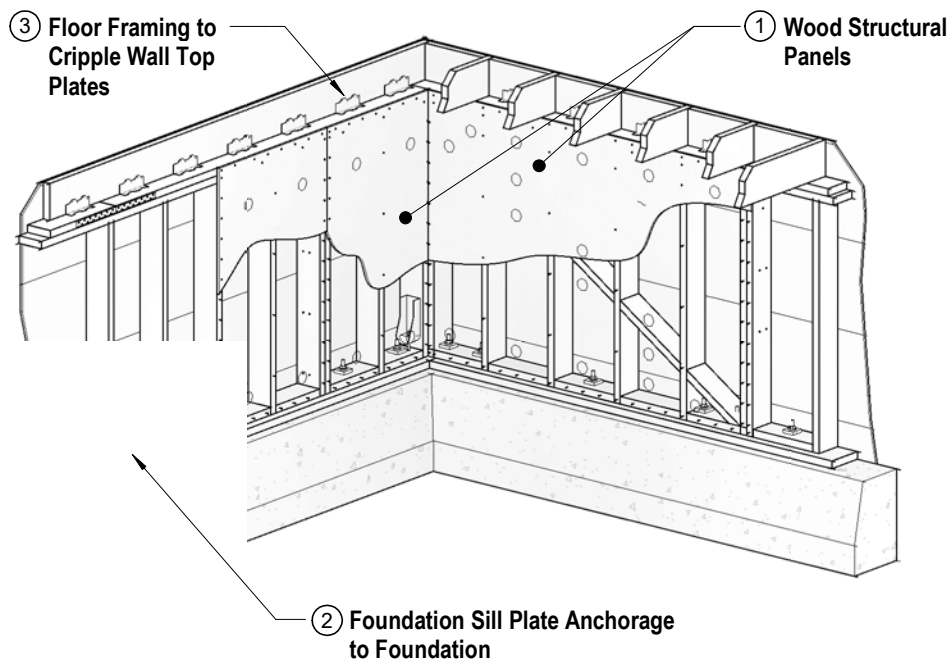


Figure 4

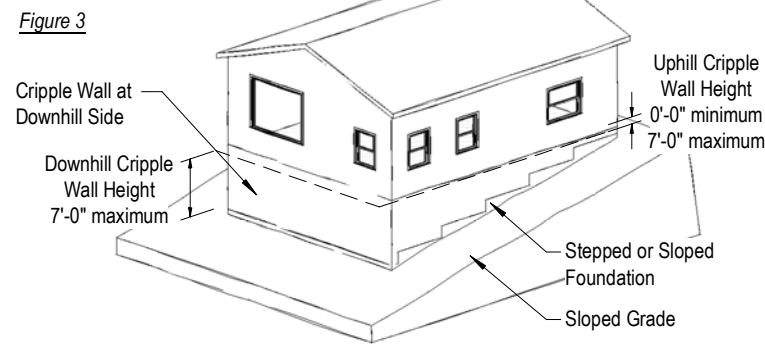
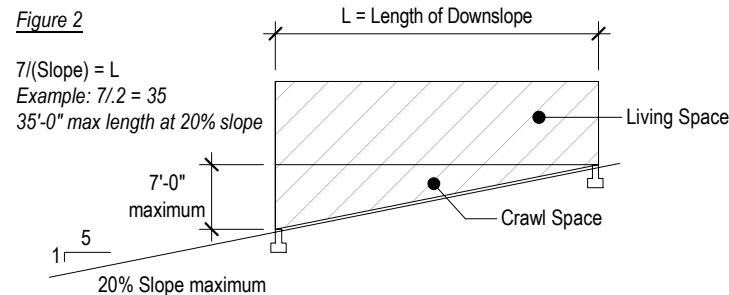
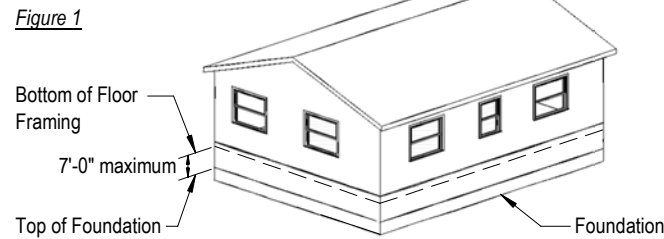


Table 1: ELIGIBILITY FOR USE

To determine if a home qualifies; answer the following:	Compliant	Non-compliant
1. The dwelling is a one- or two-family detached structure or townhouse. The dwelling unit is a townhouse and assessment and retrofit will occur for all attached townhouse dwelling units at the same time.		
2. The dwelling is a wood light-frame dwelling that is two stories or less.		
3. The dwelling is a crawlspace dwelling as defined in Chapter 2 of FEMA P-1100 Prestandard and the perimeter (not including porches or other appurtenances) is supported on: a. Cripple walls, or b. Foundation stem walls, or c. Post and pier systems to be retrofitted with cripple walls, or d. Cripple walls or foundation stem walls in combination with a slab on grade foundation.		
4. The dwelling has a continuous perimeter foundation (not including porches or other appurtenances), concrete stem walls, or will be retrofitted to have a continuous perimeter foundation.		
5. Cripple walls, where they occur, do not exceed 7'-0" in clear height.		
6. The maximum slope as measured from the top of foundations along one edge of the home to the other end does not exceed 5 to 1 (horizontal to vertical) or 20%.		
7. Weight of roofing material shall not exceed 12 psf., except for one-story crawlspace dwellings with clay tile roofing as described in footnote 1 below.		
8. Weight of exterior wall finish shall not exceed 10 psf., except that masonry wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.		
9. Weight of interior wall finish shall not exceed 8 psf, except that veneer fireplace surrounds of not more than 4" thick and of up to 100 square feet of vertical surface are permitted to exceed this weight.		
10. Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limited to 25% of the total floor area of each level.		
11. Floors in each story are at the same level and not split level, excluding slab on grade portions.		
12. The maximum square footage of the dwelling, excluding areas supported on slabs on grade, do not exceed 3,000 square feet for one story dwellings and 4,000 square feet for two-story dwellings.		
13. No part of the foundations is constructed of unreinforced masonry or stone.		
14. Clear floor to ceiling heights at any occupied level do not exceed 9'-0".		
15. There is no indication that an engineered seismic force-resisting system is present in the dwelling (engineered plans, visible tie-down brackets).		

If you answered "Compliant" to each of these questions, proceed to Sheet S3.
If you answered "Non-compliant" to any of these questions the home is not eligible to apply this plan set, unless a Registered Design Professional addresses the non-compliant issues, Section 4.5, Differing Conditions.
Footnote:
1. One story crawlspace dwellings with clay tile that weigh up to 20 psf shall be permitted to be strengthened in accordance with the provisions for two-story heavy construction as noted in the applicable Earthquake Retrofit Tables.

SHEET LIST

S0	Cover Sheet
S1	General Notes
S2	Supplemental Technical Notes
S3	Seismic Design Category, Weight Classification, and Connectors
S3.1	Earthquake Retrofit Schedule
S4	Foundation and Retrofit Layout Plan
D1	Foundation Sill to Concrete Foundation Connection Details
D2	Floor Framing to Foundation Sill Connection Details
D3	Floor Framing to Cripple Wall Connection Details
D3.1	Floor Framing to Cripple Wall Connection Details
D4	Wood Structural Panel Installation without Tie-Downs
D5	Wood Structural Panel Installation with Tie-Downs
D6	Vent Openings and Top Plate Details
D7	Foundation Replacement Details

Revision:	Date:

APPLICANT INFORMATION

APPLICANT: _____
ADDRESS: _____
PHONE: _____
SIGNATURE: _____

Cover Sheet

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: _____

S0

A. CODE

1. All work not otherwise specified shall conform to the locally adopted version of the building code or residential code. Contractor shall comply with all locally adopted building codes and ordinances.

B. GENERAL

1. The contractor is responsible for maintaining a safe job site and complying with relevant state and/or federal OSHA standards. Contractor is responsible for the means and methods for accomplishing the work shown in this plan set, including any shoring and bracing of existing construction as required to safely install new work. Exercise caution working around existing utilities, locate underground utilities before excavating, and arrange for temporary disconnection of utilities if necessary.
2. All existing under floor ventilation and access shall be maintained.

C. EXISTING CONDITIONS

1. Contractor shall confirm that existing conditions match plans and details prior to start of work.
2. Contractor shall verify that existing concrete, anchor bolts, wood framing, and other materials that will become part of the work or to which retrofit construction is attached is in reasonably sound condition and free of defects that would substantially reduce the capacity of the material. Where possible, damaged or deteriorated elements shall be repaired in place or supplemented with new elements. Otherwise damaged or deteriorated members shall be replaced. Repair or replacement shall be in accordance with the adopted building or residential code.

Table C-1 : Foundation Verification Requirements		
	Screw Anchor	Adhesive Anchor
Diameter ϕ	Torque (ft-lbs)	Torque (ft-lbs)
1/2"	35	15
5/8"	50	20

3. The Owner or Contractor shall verify that the existing concrete within all areas to receive new anchor bolts are in reasonably good condition. Examples of poor concrete quality would include excessive spalling, large rock pockets, cracks extending completely through the footing greater than 1/4" wide (closer than 6'-0" on center on average), or low strength concrete cement or mortar easily scrapable with a metal knife or trowel. Strengthening should be avoided in local areas of poor quality. Where these areas cannot be avoided, or where locations of poor quality are widespread, the new anchors shall be torque tested in accordance with Table C-1. Where torque tests continue to fail, the existing foundation system shall be replaced locally for a minimum of 30 inches on each side of the proposed anchor location.

D. NOTCHING, BORING AND CUTTING

1. Do not cut, bore, or notch structural members except as shown in these drawings or as specifically permitted by the building inspector.
Exception: Notching and boring of framing shall be permitted as per Chapter 6 of the International Residential Code (IRC)
2. When drilling in concrete, do not drill through existing reinforcing steel. If reinforcing steel is hit during drilling, move a minimum of one inch and drill relocated hole. Fill original hole with non-shrink grout.

E. CONCRETE

1. Concrete shall have a strength of not less than 3,000 psi at 28 days (design based on 2,500 psi). Concrete mixed on site shall be mixed and placed in accordance with the manufacturer's instructions using potable water.

F. REINFORCING STEEL (REBAR)

1. Reinforcing steel shall conform to ASTM A615 Grade 40 or 60, ASTM A706, or ASTM A996 Type R.
2. Reinforcing steel bend radii and other rebar detailing shall be in accordance with Concrete Reinforcing Steel Institute.
3. Minimum concrete cover over reinforcing steel:

a. Concrete cast against and permanently exposed to soil:	3 inches
b. Formed concrete exposed to weather:	2 inches
c. Concrete not exposed to weather or in contact with soil:	1-1/2 inch
d. Reinforcing steel lap splice lengths:	No. 4 No. 5
• Horizontal bars with more than 12 inches concrete below:	32 inches 42 inches
• Other bars:	24 inches 32 inches

G. STRUCTURAL STEEL

1. Structural steel W-sections, plate, bar and miscellaneous steel shall be ASTM A36, A992, or A572. Welding shall comply with AWS D1.1 requirements using prequalified welding procedures. All welding shall be conducted by welders certified for the materials and welding procedures used.
2. Bolts shall conform to ASTM A-307. Threaded rods shall conform to ASTM A-36.

H. FASTENERS

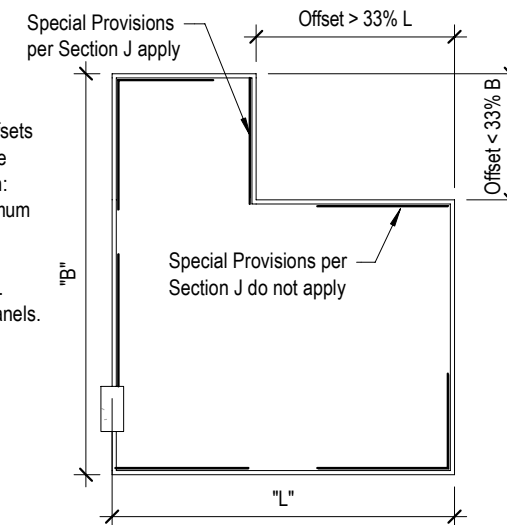
1. General
 - a. All bolts, nails, and other fasteners in contact with preservative-treated wood or exposed to weather shall be hot-dip galvanized or stainless steel.
2. Nails
 - a. Unless otherwise noted, all nails specified are to be common nails.
 - b. Special care is required when installing nails in existing framing. Where required to avoid splitting of framing, predrill to 75% of nail shank diameter.
 - c. Fasteners for wood structural panel sheathing shall be full length 8d common nails (0.131" x 2.1/2"). Drive sheathing nail head flush with face of sheathing.
 - d. Do not overdrive, countersink, or otherwise damage the outermost ply when installing nails. A nail is over-driven when it breaks the surface ply. Where nails are overdriven to the point that the veneer is fractured, add one new nail for every (2) overdriven nails. Space new nails between existing.
3. Anchor Bolts
 - a. Predrill bolt holes to not more than 1/16th inch larger than bolt or anchor bolt to be placed.
 - b. At each perimeter wall line, provide a minimum quantity of Foundation Sill Anchors as required by the Earthquake Retrofit Schedule. Place new anchors between 8 and 12 inches from the end of each foundation sill plate and distribute the remaining anchors as evenly as practical along the wall line.
 - c. Provide steel plate washers 0.229 x 3 x 3 inch minimum at all anchor bolts. Centerline of washer should be 1-1/2" to 2" from face of sheathing.
 - d. Anchor bolts shall be a maximum spacing of 64" on center for one-story dwellings and 48" on center for two-story dwellings along the entire portion of all exterior walls, except as noted in Section J.
 - e. For braced wall sections without tie-downs, provide one of the required anchor bolts within 8" of each end and one additional anchor bolt at each end as noted on Sheet D4.
 - f. For braced wall sections with tie-downs, provide one additional anchor bolt within 8" minimum and 12" maximum from tie-down as noted on Sheet D5.

I. WOOD STRUCTURAL PANEL SHEATHING

1. Wood structural panels shall be 15/32" plywood sheathing, all veneer, conforming to US Voluntary Product Standard PS-1, Exposure I or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
2. Oriented Strand Board (OSB) shall be 15/32" thick and conform to US Voluntary Product Standard PS 2 with an exposure rating of Exposure 1 or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
3. Provide 1/8-inch minimum gap at all sheathing panel ends and edges.
4. Maintain a minimum edge distance of 3/8" from center of nail to edges of sheathing, studs, or top and sill plates. See Sheet D4 for double stud at sheathing panel joints.
5. Braced wall sections closest to the ends of wall lines shall be located as near to the ends as practicable. Braced wall sections may be located away from the ends of a wall line when existing obstructions or limited clearance necessitate such relocations.
6. Braced wall sections along the length of a wall line should be nearly equal in length and should be nearly equal in spacing where possible. Using increments of existing stud spacing is expected.
7. The length of each braced wall section shall not be less than 48 inches. The length of braced wall sections without tie-downs should be equal to or exceed twice the height of the cripple wall. Exceptions are permitted when obstructions do not allow braced wall sections of the required length.

J. ADDITIONAL REQUIREMENTS FOR NON-RECTANGULAR DWELLINGS WITH "T OR "L" PLAN CONFIGURATIONS

1. Plan configurations other than rectangular such as "T" or "L" shapes that have offsets in the exterior wall lines, within the crawl space plan area, greater than 33% of the largest plan dimension shall meet the following special provisions in that direction:
 - a. Foundation sill to foundation connections along offset walls shall have a maximum spacing of 32" on center.
 - b. Floor joist to foundation sill and floor joist framing to the top of cripple wall connections along offset walls shall have a maximum spacing of 16" on center.
 - c. Cripple walls, where they occur, shall be sheathed with new wood structural panels. The sheathing shall have a minimum length of 90% of the offset wall length.



K. FRAMING

1. Framing shall be Douglas Fir-Larch, or an approved species having a greater or equal specific gravity.
2. Framing in contact with foundations or exposed to weather shall be preservative treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B). Field treat all cuts, bores and notches per AWPA M-4.

L. CONNECTOR DEVICES

1. Connectors shall be pre-engineered pre-manufactured devices, approved by the Building Official and installed in accordance with the manufacturer's instructions.
2. Connectors protected from weather shall be provided with a minimum of G90 zinc coating in accordance with ASTM A653. Connectors exposed to weather or in contact with preservative treated wood shall be provided with a minimum hot-dip galvanized coating or G185 coating in accordance with ASTM A653, and fasteners conforming to ASTM A153.
3. Connector devices shall be of the type and size specified in these drawings.
4. Connectors required by the Earthquake Retrofit Schedule (Sheet S3.1) shall be distributed equally along the length of each wall line or within the length of the braced wall panel(s).
5. Connector spacing may not be less than 8" on center.
6. Increase nail or screw length 1/2-inch minimum when installing connectors over wood structural panels.

M. POST-INSTALLED ANCHORS

1. Post-installed anchors shall be installed in accordance with the manufacturer's installation instructions.
2. Adhesive anchors shall be _____ approved _____.
3. Concrete screws shall be _____ approved _____.
4. See H.3. for additional anchor bolt requirements.

N. PERMITS

1. All work required by this Plan Set shall be permitted through the building department.

O. INSPECTIONS

1. Contractor shall coordinate with the building inspector to ensure that work is accessible for building department inspections, and shall correct non-compliant work as identified by the inspector.

P. SPECIAL INSPECTIONS

1. Special inspection by a third party inspector is not required for the following:
 - a. Concrete or reinforcing steel for foundations. Design is based on an ultimate concrete strength of 2,500 psi or less.
 - b. Installation of cast-in-place or post-installed anchor bolts.
 - c. Installation of adhesive anchors for tie-down devices, provided that each anchor is torque-tested in accordance with Table R-2, Sheet S2.
 - d. Nailing of wood structural panel shear walls, provided a building department inspection is performed.

APPLICANT: _____
PROPERTY ADDRESS: _____

General Notes

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet:

Q. PURPOSE OF SUPPLEMENTAL TECHNICAL NOTES

1. These Supplemental Technical Notes provide guidance for the installation of wood structural panels that use tie-downs and existing foundation systems. Tie-downs shall be used where there is insufficient wall length to install the length of wood structural panels specified in the Earthquake Retrofit Schedule, Sheet S3.1.
2. Where "With Tie-down" (as specified on the Earthquake Retrofit Schedule, Sheet S3.1) is used to determine the amount of strengthening required along each wall length, additional visual verification and testing of the existing foundation system is required to be completed by the owner or general contractor and approved by the Building Official, and documented in Table R-1 prior to commencing any work. Visual verification and testing shall be as noted in Section R.
3. Where these requirements are not met, a new foundation system will be required in accordance with Sheet D7.

R. EXISTING FOUNDATION REQUIREMENTS AND TESTING

1. The size of existing foundation systems at the location of new tie-down anchors shall be verified to be at least 15" deep ("D") and 8" wide ("W"). The dimension "D" shall be measured from the bottom of footing to the underside of the existing mudsill. The dimension "W" shall be measured from the top outside face of footing to the inside top face of footing. See Table R-1, item A.1.
2. Verification of the overall quality of concrete along any wall line requiring tie-downs shall be made and documented within Table R-1, item B.1. This verification shall be made by use of a minimum of two sacrificial torque tests along each wall line where tie-downs are used. These tests shall consist of installing 1/2" or 5/8" diameter screw-type bolts into the existing concrete and verifying that a value per Table R-2 can be achieved. Torque tests can be performed either by the owner, a general contractor, or a special inspection company or testing agency hired by the owner and as approved by the Building Official.
3. Where "Tie-downs" are used to determine the sheathed panel length required along a wall line, each adhesive anchor shall be torque tested in accordance with Table R-2.

S. TIE-DOWN REQUIREMENTS

1. Tie-downs shall be [redacted] equivalent with an allowable tensile load of 3075 lbs or more, installed per manufacturer's instructions.
2. End studs(s) to which tie-downs are installed, shall be 3x minimum or double 2x. For nailing at double studs, see Sheet D5.
3. All tie-downs shall use 5/8"Ø (A36) threaded rod adhesive-type anchors with minimum embedment per Detail 1, Sheet D5.

T. MINIMUM INSTALLATION REQUIREMENTS FOR TIE-DOWN ANCHORS TO FOUNDATIONS

1. All holes shall be drilled to the specified diameter and depth.
2. All holes shall be blown clean of dust with oil-free compressed air for a minimum of 4 seconds.
3. All holes shall be cleaned with a nylon brush for a minimum of 4 cycles.
4. Blow holes clean of dust with oil-free compressed air for a minimum of 4 seconds.
5. Check adhesive cartridge expiration date, open, and install per the manufacturer's instructions.
6. Fill the holes 1/2 to 2/3 full, starting at the bottom of the hole to prevent air pockets and withdraw the nozzle as the hole fills up.
7. Insert a clean and oil-free anchor turning slowly until the anchor contacts the bottom of the hole.
8. Do not disturb the anchor until fully cured. See manufacturer's instructions.

Table R-1: Verification of Existing Foundation System

Requirement	Yes or N/A	Signature of Owner or Contractor (Owner performing work)
A.1 The size of the existing foundation is greater than or equal to that specified in Section R, item 1.		Signature _____
B.1 The existing foundation has been verified to be in generally good condition at planned tie-down locations as specified in Section R, item 2.		Signature _____
C.1 The capacity of each new tie-down anchor has been verified by passing the torque tests specified in Table R-2.		Signature _____
D.1 All adhesive anchors were installed per the manufacturer's instructions per the minimum steps as noted in Section T.		Signature _____

Table R-2: Foundation Verification Requirements

	Screw Anchor	Adhesive Anchor
Diameter Ø	Torque (ft-lbs)	Torque (ft-lbs)
1/2"	35	15
5/8"	50	20

APPLICANT: _____

PROPERTY ADDRESS: _____

Supplemental Technical Notes

(Where Tie-downs are Required)

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

Seismic Design Category (SDC)

- The first factor taken into consideration when determining the appropriate amount of earthquake strengthening is the anticipated level of seismic shaking or S_{DS} value, which is directly related to the Seismic Design Category (SDC).
- To find the appropriate S_{DS} value, which is either 1.0, 1.2, or 1.5, you must first determine your Seismic Design Category (SDC) by clicking the link below.
 - In your internet browser
 - Click on one of the five (5) geographic areas listed to find your location on the appropriate map.
 - Locate your SDC (SDC A-SDC E) by the color contour shown on the map which corresponds to the % g values shown.
 - For SDC A-D₁, use $S_{DS} = 1.0$.
 - For SDC D₂, use $S_{DS} = 1.2$ unless the site class can be determined as A, B, or D, in which case use $S_{DS} = 1.0$.
 - For SDC E, use $S_{DS} = 1.5$

Note: where your location is on, or close to, the border of two SDC's, it is prudent to choose the higher value.

- Make a note of the appropriate S_{DS} value. It will be used together with the number of stories the dwelling has to determine the appropriate Earthquake Retrofit Schedule (Sheet S3.1) to use in preparing and submitting the plans. You will only use one of the following six Earthquake Retrofit Schedule Sheets. Do not submit the unused S3.1 sheets to the Building Official.

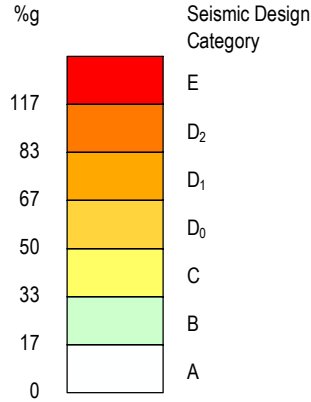


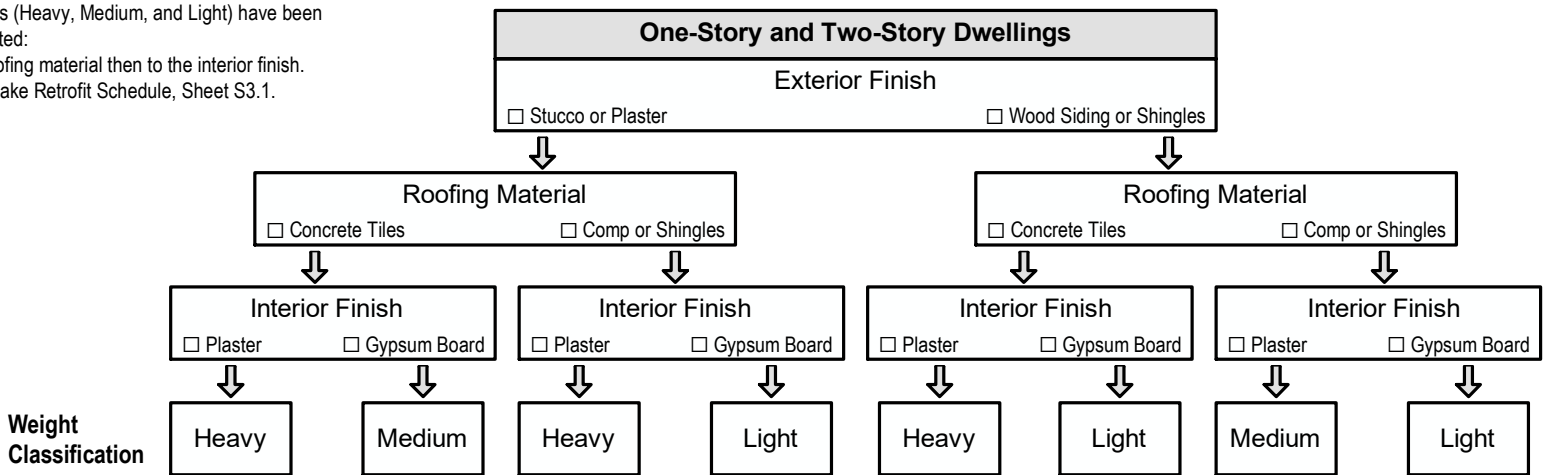
Figure 1. SDC versus %g

Weight Classification

The next factor used to establish the appropriate amount of earthquake strengthening is the dwelling weight. For the purposes of this Plan Set, three weight classifications (Heavy, Medium, and Light) have been established as described below. Using the flowchart presented:

- Start with the exterior finish and move progressively to roofing material then to the interior finish.
- Note the weight classification result for use in the Earthquake Retrofit Schedule, Sheet S3.1.

- Specific notes for exterior, interior and roof coverings:
- The "wood siding or shingles" exterior finish category also includes finishes of similar weight, including but not limited to fiber-cement and aluminum siding.
 - The "comp or shingles" roofing material category also includes roofing materials of similar weight, including but not limited to roll roofing, built-up felt roofing, single-ply membrane roofing, and metal roofing.
 - The "gypsum board" interior finish category also includes wall finish materials of similar weight, including but not limited to wood board or panel siding.
 - The exterior finish, roofing material, and interior finish categories are intended to be identified based on the predominant materials used in construction. Where interior or exterior finishes vary, a heavier type finish shall be assumed where 25% or more of the heavier finish type exists within the dwelling.



Connectors

- Verify and follow manufacturer's written instructions.
- Connector images are general in nature only. Individual manufacturer's connectors may vary.
- Any of the connectors listed within a particular group may be used for strengthening the particular condition.
- This Plan Set was developed using the listed capacity.
- Where connectors listed within the applicable Earthquake Retrofit Schedule will not fit within a particular wall line due to limitations in length, alternate connections may be substituted but shall be designed or selected by a registered design professional and approved by the Building Official.

CONNECTORS

IMAGE			CAPACITY
	TYPE A		1530#
	TYPE B		960#
	TYPE C		875#
	TYPE D		565#
	TYPE E		740#
	TYPE F (Note 3)		590#
	TYPE G		445#
	TYPE H		
	TYPE S1		2050#

ANCHOR BOLTS

		EMBEDMENT DEPTH	
		1/2" ϕ	5/8" ϕ
SCREW-TYPE			
ADHESIVE	Threaded Rod with: SET Adhesive	4-1/2"	5"

TIE-DOWNS

Supplemental Technical Notes, Sheet S2, Section S

IMAGE			CAPACITY (ASD)

Note: The allowable ASD capacity used for development of this plan set has been reduced to 3000# based on anchorage to existing foundation systems. Tie down anchors must be installed per Detail 1, Sheet D5.

APPLICANT: _____
PROPERTY ADDRESS: _____

Seismic Design Category, Weight Classification, and Connectors

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

EARTHQUAKE RETROFIT SCHEDULE (S_{Ds}= 1.0 Seismic) ONE-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								⑥ Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length								
			Wood Structural Panels								⑦ Floor to Cripple Wall or Floor to Foundation Sill								
			④ Cripple Wall Height								Foundation Sill Anchors								
up to 1'	1'-1" to 2'	2'-1" to 4'-0"	4'-1" to 6'-0"	6'-1" to 7'-0"	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"∅ Bolt	5/8"∅ Bolt	Type "D"	Type "E" or "F"	Type "G"		
1-Story Light Construction	up to 800	<input type="checkbox"/>	5.3'	5.3'	8.0'	5.3'	9.3'	5.3'	9.3'	6.7'	4"	4	7	7	7	5	11	10	14
	801 to 1000	<input type="checkbox"/>	6.7'	6.7'	8.0'	6.7'	10.7'	6.7'	10.7'	8.0'	4"	5	8	8	8	6	13	12	16
	1001 to 1200	<input type="checkbox"/>	6.7'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	4"	6	9	10	10	7	15	14	19
	1201 to 1500	<input type="checkbox"/>	8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	13.3'	9.3'	4"	7	11	12	12	8	18	17	22
	1501 to 2000	<input type="checkbox"/>	9.3'	10.7'	13.3'	10.7'	14.7'	10.7'	16.0'	12.0'	4"	9	14	15	15	10	23	22	29
	2001 to 2500	<input type="checkbox"/>	12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	18	18	12	27	26	35
	2501 to 3000	<input type="checkbox"/>	14.7'	14.7'	16.0'	14.7'	18.7'	14.7'	20.0'	16.0'	4"	12	19	21	21	14	32	31	40
1-Story Medium Construction	up to 800	<input type="checkbox"/>	5.3'	6.7'	8.0'	5.3'	9.3'	6.7'	10.7'	6.7'	3"	5	8	8	8	6	13	12	16
	801 to 1000	<input type="checkbox"/>	5.3'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	3"	6	9	10	10	7	15	14	19
	1001 to 1200	<input type="checkbox"/>	6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	3"	7	10	11	11	8	17	17	22
	1201 to 1500	<input type="checkbox"/>	8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	3"	8	12	13	13	9	20	20	26
	1501 to 2000	<input type="checkbox"/>	9.3'	10.7'	13.3'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	10	15	17	17	11	25	24	32
	2001 to 2500	<input type="checkbox"/>	10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	13.3'	3"	12	18	20	20	14	30	29	38
	2501 to 3000	<input type="checkbox"/>	12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	3"	13	21	23	23	16	35	34	45
1-Story Heavy Construction	up to 800	<input type="checkbox"/>	5.3'	6.7'	8.0'	5.3'	10.7'	6.7'	10.7'	8.0'	2"	6	9	10	10	7	15	14	18
	801 to 1000	<input type="checkbox"/>	6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	2"	7	10	11	11	8	17	17	22
	1001 to 1200	<input type="checkbox"/>	6.7'	8.0'	10.7'	8.0'	12.0'	9.3'	13.3'	10.7'	2"	8	12	13	13	9	20	19	25
	1201 to 1500	<input type="checkbox"/>	8.0'	9.3'	12.0'	9.3'	14.7'	10.7'	14.7'	12.0'	2"	9	14	15	15	11	24	23	30
	1501 to 2000	<input type="checkbox"/>	9.3'	10.7'	14.7'	10.7'	16.0'	12.0'	17.3'	13.3'	2"	11	18	19	19	13	30	29	38
	2001 to 2500	<input type="checkbox"/>	10.7'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	36	34	45
	2501 to 3000	<input type="checkbox"/>	12.0'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	17.3'	2"	16	25	27	27	18	41	40	53

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that where using 1/2" or 5/8" bolts, one additional anchor is required at the end of each braced wall panel per Sheet D4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the _____ listed _____ capacity _____. Required number of connectors on the Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be designed or specified by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the flowchart on Sheet S3 to determine "Weight Category".
- Find the home's Total Floor Area in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - Approximate 1st floor area over crawlspace: _____
(Do not include areas built over slab-on-grade.)
- Check the box that matches your home's construction type, number of stories, and total floor area. You will use information in this row of the schedule to determine length of wood structural panels, nailing requirements, quantities of hardware, etc.
- Measure the maximum height of the cripple wall along each wall line of the house.
- Determine the length of wood structural panel bracing required. The columns contain the length of required bracing, depending on the height of the cripple wall. The length of bracing is given for cripple wall heights of zero to 1', 1' to 2', 2' to 4', 4' to 6', and 6' to 7'. Furthermore, choices are given for bracing without tie-downs and with tie-downs. If the cripple wall height changes along the length of the wall, use the tallest height to determine the required bracing length. Follow the row across from the total floor area that you checked for your home (in Step 2) to find the bracing length for the cripple wall height on each side of the house. Review General Notes, Sheet S1, Section J for instructions at non-rectangular "T" or "L" shaped dwellings. Check boxes where Special Provisions apply.
- Determine the number of Foundation Sill Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or 1/2"∅ or 5/8"∅ anchor bolts. (∅ = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Cripple Wall or Foundation Sill connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths found in ⑤. Check the boxes for the anchor and connector types you plan to use. The length of new cripple wall sheathing should be distributed along a wall line either in one full length or in a maximum of two panel lengths of approximately equal length (offset walls can have three). If you intend to use tie-downs, check the box for tie-downs for each wall line where use is intended. Check the box on line 4, and read the Supplemental Technical Notes for additional information. Where the length of required panel does not fit within the available length, the dwelling must have an engineered solution. Alternately, if 100% of the length along any particular wall can be sheathed, then that wall line shall be considered acceptable and an engineered solution is not required.

⑧ RETROFIT SUMMARY	
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS	
1. Minimum required length of Wood Structural Panels per wall line: (check boxes where condition applies)	
North Wall _____ ft x2 <input type="checkbox"/> with tie-downs <input type="checkbox"/> with Special Provisions	
East Wall _____ ft x2 <input type="checkbox"/> with tie-downs <input type="checkbox"/> with Special Provisions	
South Wall _____ ft x2 <input type="checkbox"/> with tie-downs <input type="checkbox"/> with Special Provisions	
West Wall _____ ft x2 <input type="checkbox"/> with tie-downs <input type="checkbox"/> with Special Provisions	
2. Panel Edge Nailing _____" on center.	
3. New Foundation Sill Anchorage: Additional types/quantity (if used):	
North Wall Type: _____ Min required: _____	Type: _____ Min required: _____
East Wall Type: _____ Min required: _____	Type: _____ Min required: _____
South Wall Type: _____ Min required: _____	Type: _____ Min required: _____
West Wall Type: _____ Min required: _____	Type: _____ Min required: _____
4. Floor Framing Connectors (to Cripple Wall or Foundation Sill): Additional types/quantity (if used):	
North Wall Type: _____ Min required: _____	Type: _____ Min required: _____
East Wall Type: _____ Min required: _____	Type: _____ Min required: _____
South Wall Type: _____ Min required: _____	Type: _____ Min required: _____
West Wall Type: _____ Min required: _____	Type: _____ Min required: _____
5. <input type="checkbox"/> Check this box if tie-downs and SUPPLEMENTAL TECHNICAL NOTES on Sheet S2 will be used.	

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule
S_{Ds} = 1.0 One-Story
Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of
One- and Two-Family Dwellings

Date: _____
Sheet: _____
S3.1

EARTHQUAKE RETROFIT SCHEDULE (S_{DS}= 1.2 High Seismic) ONE-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								⑥ Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length								
			Wood Structural Panels										⑦ Floor to Cripple Wall or Floor to Foundation Sill						
			④ Cripple Wall Height								Panel Edge Nailing	Foundation Sill Anchors		Floor to Cripple Wall or Floor to Foundation Sill					
			up to 1' Without Tie-downs	1'-1" to 2' Without Tie-downs	2'-1" to 4'-0" Without Tie-downs	4'-1" to 6'-0" With Tie-downs	6'-1" to 7'-0" Without Tie-downs	6'-1" to 7'-0" With Tie-downs	Without Tie-downs	With Tie-downs		Without Tie-downs	With Tie-downs	Type "A"	Type "B"	Type "C"	1/2"ø Bolt	5/8"ø Bolt	Type "D"
1-Story Light Construction	up to 800		6.7'	6.7'	8.0'	6.7'	10.7'	6.7'	10.7'	8.0'	4"	5	8	8	8	6	13	12	16
	801 to 1000		6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	8.0'	4"	6	9	10	10	7	15	15	19
	1001 to 1200		8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	13.3'	9.3'	4"	7	11	12	12	8	18	17	22
	1201 to 1500		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	10.7'	4"	8	13	14	14	10	21	20	27
	1501 to 2000		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	18	18	12	27	26	34
	2001 to 2500		14.7'	14.7'	17.3'	14.7'	20.0'	14.7'	21.3'	16.0'	4"	12	19	21	21	15	33	31	41
2501 to 3000		17.3'	17.3'	18.7'	17.3'	21.3'	17.3'	22.7'	17.3'	4"	14	23	25	25	17	38	37	48	
1-Story Medium Construction	up to 800		5.3'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	3"	6	9	10	10	7	15	15	19
	801 to 1000		6.7'	8.0'	10.7'	6.7'	12.0'	8.0'	13.3'	9.3'	3"	7	11	12	12	8	18	17	23
	1001 to 1200		8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	3"	8	12	13	13	9	21	20	26
	1201 to 1500		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	9	15	16	16	11	24	23	31
	1501 to 2000		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	39
	2001 to 2500		13.3'	13.3'	17.3'	13.3'	20.0'	14.7'	21.3'	16.0'	3"	14	22	24	24	16	36	35	46
2501 to 3000		14.7'	14.7'	18.7'	14.7'	21.3'	17.3'	22.7'	18.7'	3"	16	25	27	27	19	42	40	53	
1-Story Heavy Construction	up to 800		6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	2"	7	10	11	11	8	17	17	22
	801 to 1000		6.7'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	2"	8	12	14	13	9	21	20	26
	1001 to 1200		8.0'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	2"	9	14	16	15	11	24	23	30
	1201 to 1500		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	2"	11	17	18	18	13	28	27	36
	1501 to 2000		10.7'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	36	34	45
	2001 to 2500		13.3'	14.7'	18.7'	13.3'	21.3'	16.0'	22.7'	17.3'	2"	16	25	28	28	19	43	41	54
2501 to 3000		14.7'	16.0'	20.0'	16.0'	22.7'	18.7'	25.3'	20.0'	2"	19	29	32	32	22	50	48	63	

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the flowchart on Sheet S3 to determine "Weight Category".
- ② Find the home's Total Floor Area in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate 1st floor area over crawlspace: _____
(Do not include areas built over slab-on-grade.)
- ③ Check the box that matches your home's construction type, number of stories, and total floor area. You will use information in this row of the schedule to determine length of wood structural panels, nailing requirements, quantities of hardware, etc.
- ④ Measure the maximum height of the cripple wall along each wall line of the house.
- ⑤ Determine the length of wood structural panel bracing required. The columns contain the length of required bracing, depending on the height of the cripple wall. The length of bracing is given for cripple wall heights of zero to 1', 1' to 2', 2' to 4', 4' to 6', and 6' to 7'. Furthermore, choices are given for bracing without tie-downs and with tie-downs. If the cripple wall height changes along the length of the wall, use the tallest height to determine the required bracing length. Follow the row across from the total floor area that you checked for your home (in Step 2) to find the bracing length for the cripple wall height on each side of the house. Review General Notes, Sheet S1, Section J for instructions at non-rectangular "T" or "L" shaped dwellings. Check boxes where Special Provisions apply.
- ⑥ Determine the number of Foundation Sill Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or 1/2"ø or 5/8"ø anchor bolts. (ø = diameter of the bolts.) See Sheet S3.
- ⑦ Determine the number of Floor to Cripple Wall or Foundation Sill connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑧ Complete the Retrofit Summary for your project. Fill in the lengths found in ⑤. Check the boxes for the anchor and connector types you plan to use. The length of new cripple wall sheathing should be distributed along a wall line either in one full length or in a maximum of two panel lengths of approximately equal length (offset walls can have three). If you intend to use tie-downs, check the box for tie-downs for each wall line where use is intended. Check the box on line 4, and read the Supplemental Technical Notes for additional information. Where the length of required panel does not fit within the available length, the dwelling must have an engineered solution. Alternately, if 100% of the length along any particular wall can be sheathed, then that wall line shall be considered acceptable and an engineered solution is not required.

**RETROFIT SUMMARY
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS**

1. Minimum required length of Wood Structural Panels per wall line: (check boxes where condition applies)

North Wall _____ ft x2 with tie-downs with Special Provisions
 East Wall _____ ft x2 with tie-downs with Special Provisions
 South Wall _____ ft x2 with tie-downs with Special Provisions
 West Wall _____ ft x2 with tie-downs with Special Provisions

2. Panel Edge Nailing _____" on center.

3. New Foundation Sill Anchorage: Additional types/quantity (if used):
 North Wall Type: _____ Min required: _____ Type: _____ Min required: _____
 East Wall Type: _____ Min required: _____ Type: _____ Min required: _____
 South Wall Type: _____ Min required: _____ Type: _____ Min required: _____
 West Wall Type: _____ Min required: _____ Type: _____ Min required: _____

4. Floor Framing Connectors (to Cripple Wall or Foundation Sill): Additional types/quantity (if used):
 North Wall Type: _____ Min required: _____ Type: _____ Min required: _____
 East Wall Type: _____ Min required: _____ Type: _____ Min required: _____
 South Wall Type: _____ Min required: _____ Type: _____ Min required: _____
 West Wall Type: _____ Min required: _____ Type: _____ Min required: _____

5. Check this box if tie-downs and SUPPLEMENTAL TECHNICAL NOTES on Sheet S2 will be used.

Notes:

- 1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that where using 1/2" or 5/8" bolts, one additional anchor is required at the end of each braced wall panel per Sheet D4.
- 2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- 3. Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- 4. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- 5. This Plan Set was developed using the _____ listed _____ capacity _____. Required number of connectors on the Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be designed or specified by a Registered Design Professional.
- 6. Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

APPLICANT: _____
 PROPERTY ADDRESS: _____

**Earthquake Retrofit Schedule
S_{DS} = 1.2 One-Story**

**Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of
 One- and Two-Family Dwellings**

Date: _____
 Sheet: _____

EARTHQUAKE RETROFIT SCHEDULE (S_{DS}= 1.5 Very High Seismic) ONE-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								⑥ Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length									
			Wood Structural Panels										Foundation Sill Anchors				⑦ Floor to Cripple Wall or Floor to Foundation Sill			
			④ Cripple Wall Height									Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"		4'-1" to 6'-0"		6'-1" to 7'-0"											
	Without Tie-downs	Without Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs												
1-Story Light Construction	up to 800		8.0'	8.0'	10.7'	8.0'	12.0'	8.0'	13.3'	9.3'	4"	6	10	10	10	7	16	15	20	
	801 to 1000		9.3'	9.3'	12.0'	9.3'	13.3'	9.3'	14.7'	10.7'	4"	7	11	12	12	9	19	18	24	
	1001 to 1200		10.7'	10.7'	13.3'	10.7'	16.0'	10.7'	16.0'	12.0'	4"	8	13	14	14	10	22	21	28	
	1201 to 1500		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	17	17	12	26	25	33	
	1501 to 2000		14.7'	14.7'	17.3'	14.7'	21.3'	16.0'	22.7'	16.0'	4"	13	20	22	22	15	34	32	43	
	2001 to 2500		18.7'	18.7'	20.0'	18.7'	24.0'	18.7'	25.3'	18.7'	4"	15	24	27	27	18	41	39	52	
2501 to 3000		21.3'	21.3'	22.7'	21.3'	26.7'	21.3'	28.0'	21.3'	4"	18	28	31	31	21	48	46	60		
1-Story Medium Construction	up to 800		6.7'	8.0'	10.7'	6.7'	13.3'	9.3'	13.3'	9.3'	3"	7	11	12	12	9	19	18	24	
	801 to 1000		8.0'	9.3'	12.0'	8.0'	14.7'	10.7'	16.0'	10.7'	3"	9	13	15	15	10	22	21	28	
	1001 to 1200		9.3'	10.7'	13.3'	9.3'	16.0'	12.0'	17.3'	12.0'	3"	10	15	17	17	11	26	25	32	
	1201 to 1500		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	38	
	1501 to 2000		13.3'	13.3'	17.3'	13.3'	21.3'	16.0'	22.7'	17.3'	3"	14	23	25	25	17	38	36	48	
	2001 to 2500		16.0'	16.0'	20.0'	16.0'	22.7'	17.3'	25.3'	20.0'	3"	17	27	29	29	20	45	43	57	
2501 to 3000		18.7'	18.7'	21.3'	18.7'	25.3'	20.0'	26.7'	21.3'	3"	20	31	34	34	23	53	50	67		
1-Story Heavy Construction	up to 800		8.0'	9.3'	12.0'	8.0'	13.3'	10.7'	14.7'	10.7'	2"	8	13	14	14	10	22	21	27	
	801 to 1000		8.0'	10.7'	13.3'	9.3'	16.0'	12.0'	17.3'	12.0'	2"	10	15	17	17	11	26	25	33	
	1001 to 1200		9.3'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	13.3'	2"	11	18	19	19	13	30	28	37	
	1201 to 1500		10.7'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	35	34	45	
	1501 to 2000		13.3'	16.0'	18.7'	14.7'	22.7'	17.3'	24.0'	18.7'	2"	17	26	29	29	20	44	43	56	
	2001 to 2500		14.7'	17.3'	21.3'	16.0'	25.3'	20.0'	26.7'	21.3'	2"	20	32	35	34	24	53	51	67	
2501 to 3000		17.3'	20.0'	24.0'	18.7'	28.0'	22.7'	29.3'	24.0'	2"	23	37	40	40	27	62	59	79		

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the flowchart on Sheet S3 to determine "Weight Category".
- ② Find the home's Total Floor Area in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
 - a. Approximate 1st floor area over crawlspace:
(Do not include areas built over slab-on-grade.) _____
- ③ Check the box that matches your home's construction type, number of stories, and total floor area. You will use information in this row of the schedule to determine length of wood structural panels, nailing requirements, quantities of hardware, etc.
- ④ Measure the maximum height of the cripple wall along each wall line of the house.
- ⑤ Determine the length of wood structural panel bracing required. The columns contain the length of required bracing, depending on the height of the cripple wall. The length of bracing is given for cripple wall heights of zero to 1', 1' to 2', 2' to 4', 4' to 6', and 6' to 7'. Furthermore, choices are given for bracing without tie-downs and with tie-downs. If the cripple wall height changes along the length of the wall, use the tallest height to determine the required bracing length. Follow the row across from the total floor area that you checked for your home (in Step 2) to find the bracing length for the cripple wall height on each side of the house. Review General Notes, Sheet S1, Section J for instructions at non-rectangular "T" or "L" shaped dwellings. Check boxes where Special Provisions apply.
- ⑥ Determine the number of Foundation Sill Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- ⑦ Determine the number of Floor to Cripple Wall or Foundation Sill connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑧ Complete the Retrofit Summary for your project. Fill in the lengths found in ⑤. Check the boxes for the anchor and connector types you plan to use. The length of new cripple wall sheathing should be distributed along a wall line either in one full length or in a maximum of two panel lengths of approximately equal length (offset walls can have three). If you intend to use tie-downs, check the box for tie-downs for each wall line where use is intended. Check the box on line 4, and read the Supplemental Technical Notes for additional information. Where the length of required panel does not fit within the available length, the dwelling must have an engineered solution. Alternately, if 100% of the length along any particular wall can be sheathed, then that wall line shall be considered acceptable and an engineered solution is not required.

RETROFIT SUMMARY BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Minimum required length of Wood Structural Panels per wall line: (check boxes where condition applies)

North Wall	_____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
East Wall	_____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
South Wall	_____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
West Wall	_____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
 2. Panel Edge Nailing _____" on center.
 3. New Foundation Sill Anchorage:

North Wall	Type: _____	Min required: _____	Additional types/quantity (if used): _____
East Wall	Type: _____	Min required: _____	Type: _____ Min required: _____
South Wall	Type: _____	Min required: _____	Type: _____ Min required: _____
West Wall	Type: _____	Min required: _____	Type: _____ Min required: _____
 4. Floor Framing Connectors (to Cripple Wall or Foundation Sill):

North Wall	Type: _____	Min required: _____	Additional types/quantity (if used): _____
East Wall	Type: _____	Min required: _____	Type: _____ Min required: _____
South Wall	Type: _____	Min required: _____	Type: _____ Min required: _____
West Wall	Type: _____	Min required: _____	Type: _____ Min required: _____
5. Check this box if tie-downs and SUPPLEMENTAL TECHNICAL NOTES on Sheet S2 will be used.

- Notes:
1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that where using 1/2" or 5/8" bolts, one additional anchor is required at the end of each braced wall panel per Sheet D4.
 2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
 3. Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
 4. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
 5. This Plan Set was developed using the _____ listed _____ capacity _____. Required number of connectors on the Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be designed or specified by a Registered Design Professional.
 6. Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule
S_{DS} = 1.5 One-Story
Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: _____

S3.1

EARTHQUAKE RETROFIT SCHEDULE (S_{Ds}= 1.0 Seismic) TWO-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length								
			④ Cripple Wall Height								⑥ Foundation Sill Anchors					⑦ Floor to Cripple Wall or Floor to Foundation Sill			
			up to 1' Without Tie-downs	1'-1" to 2' Without Tie-downs	2'-1" to 4'-0" Without Tie-downs	4'-1" to 6'-0" With Tie-downs	6'-1" to 7'-0" Without Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"∅ Bolt	5/8"∅ Bolt	Type "D"	Type "E" or "F"
2-Story Light Construction	up to 1600		8.0'	8.0'	10.7'	8.0'	12.0'	9.3'	13.3'	9.3'	4"	7	10	11	11	8	17	17	22
	1601 to 2000		9.3'	9.3'	12.0'	9.3'	13.3'	10.7'	14.7'	10.7'	4"	8	12	13	13	9	20	19	26
	2001 to 2400		10.7'	10.7'	13.3'	10.7'	14.7'	10.7'	16.0'	12.0'	4"	9	14	15	15	10	23	22	29
	2401 to 3000		12.0'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	13.3'	4"	10	16	18	18	12	27	26	34
	3001 to 4000		14.7'	14.7'	17.3'	16.0'	20.0'	16.0'	21.3'	16.0'	4"	13	20	22	22	15	34	32	43
2-Story Medium Construction	up to 1600		8.0'	9.3'	10.7'	8.0'	13.3'	9.3'	13.3'	10.7'	3"	7	11	12	12	9	19	18	24
	1601 to 2000		9.3'	10.7'	12.0'	9.3'	14.7'	10.7'	14.7'	12.0'	3"	9	13	15	15	10	22	22	28
	2001 to 2400		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	16.0'	13.3'	3"	10	15	17	17	11	26	25	32
	2401 to 3000		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	39
	3001 to 4000		13.3'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	17.3'	3"	14	23	25	25	17	38	36	48
2-Story Heavy Construction	up to 1600		9.3'	9.3'	12.0'	9.3'	13.3'	10.7'	14.7'	12.0'	2"	9	14	16	16	11	24	23	30
	1601 to 2000		9.3'	10.7'	13.3'	10.7'	14.7'	12.0'	16.0'	13.3'	2"	11	17	18	18	13	28	27	35
	2001 to 2400		10.7'	12.0'	14.7'	10.7'	16.0'	13.3'	17.3'	14.7'	2"	12	19	21	21	14	32	31	41
	2401 to 3000		12.0'	13.3'	16.0'	13.3'	18.7'	14.7'	18.7'	16.0'	2"	14	23	25	25	17	38	37	48
	3001 to 4000		13.3'	16.0'	18.7'	14.7'	21.3'	17.3'	22.7'	18.7'	2"	18	28	31	31	21	48	46	60

Notes:

- 1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that where using 1/2" or 5/8" bolts, one additional anchor is required at the end of each braced wall panel per Sheet D4.
- 2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- 3. Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- 4. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- 5. This Plan Set was developed using the listed capacity. Required number of connectors on the Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be designed or specified by a Registered Design Professional.
- 6. Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

INSTRUCTIONS

- ① Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- ② Find the home's Total Floor Area in the schedule, this number should be at least as large as the number calculated in 2.c. Do not use a smaller number, even if it is closer.
 - a. Approximate 1st floor area over crawl space: _____ (Do not include areas built over slab-on-grade.)
 - b. Approximate 2nd floor area over crawl space: _____ (Do not include areas where the 1st floors over slab-on-grade.)
 - c. Total approximate square footage: _____ (line a + line b)
- ③ Check the box that matches your home's construction type, number of stories, and total floor area. You will use information in this row of the schedule to determine length of wood structural panels, nailing requirements, quantities of hardware, etc.
- ④ Measure the maximum height of the cripple wall along each wall line of the house.
- ⑤ Determine the length of wood structural panel bracing required. The columns contain the length of required bracing, depending on the height of the cripple wall. The length of bracing is given for cripple wall heights of zero to 1', 1' to 2', 2' to 4', 4' to 6', and 6' to 7'. Furthermore, choices are given for bracing without tie-downs and with tie-downs. If the cripple wall height changes along the length of the wall, use the tallest height to determine the required bracing length. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for the cripple wall height on each side of the house. Review General Notes, Sheet S1, Section J for instructions at non-rectangular "T" or "L" shaped dwellings. Check boxes where Special Provisions apply.
- ⑥ Determine the number of Foundation Sill Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or 1/2"∅ or 5/8"∅ anchor bolts. (∅ = diameter of the bolts.) See Sheet S3.
- ⑦ Determine the number of Floor to Cripple Wall or Foundation Sill connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- ⑧ Complete the Retrofit Summary for your project. Fill in the lengths of Wood Structural Panels found in ⑤. Fill in the type and quantity of anchors used on each wall line. The length of new cripple wall sheathing should be distributed along a wall line either in one full length or in a maximum of two panel lengths of approximately equal length (offset walls can have three). If you intend to use tie-downs, check the box for tie-downs for each wall line where use is intended. Check the box on line 5, and read the Supplemental Technical Notes for additional information. Where the length of required panel does not fit within the available length, the dwelling must have an engineered solution. Alternately, if 100% of the length along any particular wall can be sheathed, then that wall line shall be considered acceptable and an engineered solution is not required.

**⑧ RETROFIT SUMMARY
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS**

- 1. Minimum required length of Wood Structural Panels per wall line: (check boxes where condition applies)
North Wall _____ ft x2 with tie-downs with Special Provisions
East Wall _____ ft x2 with tie-downs with Special Provisions
South Wall _____ ft x2 with tie-downs with Special Provisions
West Wall _____ ft x2 with tie-downs with Special Provisions
- 2. Panel Edge Nailing _____" on center.
- 3. New Foundation Sill Anchorage:
North Wall Type: _____ Min required: _____ Additional types/quantity (if used): Type: _____ Min required: _____
East Wall Type: _____ Min required: _____ Type: _____ Min required: _____
South Wall Type: _____ Min required: _____ Type: _____ Min required: _____
West Wall Type: _____ Min required: _____ Type: _____ Min required: _____
- 4. Floor Framing Connectors (to Cripple Wall or Foundation Sill): Additional types/quantity (if used):
North Wall Type: _____ Min required: _____ Type: _____ Min required: _____
East Wall Type: _____ Min required: _____ Type: _____ Min required: _____
South Wall Type: _____ Min required: _____ Type: _____ Min required: _____
West Wall Type: _____ Min required: _____ Type: _____ Min required: _____
- 5. Check this box if tie-downs and SUPPLEMENTAL TECHNICAL NOTES on Sheet S2 will be used.

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule
S_{Ds} = 1.0 Two-Story
Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **S3.1**

EARTHQUAKE RETROFIT SCHEDULE (S_{DS}= 1.2 High Seismic) TWO-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies <input type="checkbox"/>	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length								
			Wood Structural Panels								⑥ Foundation Sill Anchors					⑦ Floor to Cripple Wall or Floor to Foundation Sill			
			④ Cripple Wall Height								Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"
up to 1'	1'-1" to 2'	2'-1" to 4'-0"	4'-1" to 6'-0"	6'-1" to 7'-0"	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs		Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs				
2-Story Light Construction	up to 1600		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	4"	8	12	13	13	9	21	20	26
	1601 to 2000		10.7'	10.7'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	4"	9	14	16	16	11	24	23	31
	2001 to 2400		12.0'	12.0'	14.7'	13.3'	17.3'	13.3'	18.7'	14.7'	4"	10	16	18	18	12	28	26	35
	2401 to 3000		14.7'	14.7'	16.0'	14.7'	20.0'	14.7'	20.0'	16.0'	4"	12	19	21	21	14	33	31	41
	3001 to 4000		17.3'	18.7'	18.7'	18.7'	22.7'	18.7'	24.0'	18.7'	4"	15	24	26	26	18	40	39	51
2-Story Medium Construction	up to 1600		9.3'	10.7'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	9	14	15	15	10	23	22	29
	1601 to 2000		10.7'	12.0'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	3"	10	16	18	17	12	27	26	34
	2001 to 2400		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	31	29	39
	2401 to 3000		13.3'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	16.0'	3"	14	22	24	24	16	36	35	46
	3001 to 4000		16.0'	16.0'	20.0'	16.0'	22.7'	18.7'	24.0'	20.0'	3"	17	27	30	29	20	46	44	58
2-Story Heavy Construction	up to 1600		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	16.0'	13.3'	2"	11	17	19	18	13	28	27	36
	1601 to 2000		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	2"	13	20	22	22	15	34	32	42
	2001 to 2400		12.0'	13.3'	16.0'	13.3'	18.7'	14.7'	20.0'	16.0'	2"	15	23	25	25	17	38	37	49
	2401 to 3000		13.3'	14.7'	18.7'	14.7'	21.3'	17.3'	21.3'	18.7'	2"	17	27	30	29	20	46	44	58
	3001 to 4000		16.0'	17.3'	21.3'	17.3'	24.0'	20.0'	25.3'	21.3'	2"	21	34	37	37	25	57	55	72

INSTRUCTIONS

- Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
- Find the home's Total Floor Area in the schedule, this number should be at least as large as the number calculated in 2.c. Do not use a smaller number, even if it is closer.

a. Approximate 1st floor area over crawl space: _____
(Do not include areas built over slab-on-grade.)

b. Approximate 2nd floor area over crawl space: _____
(Do not include areas where the 1st floors over slab-on-grade.)

c. Total approximate square footage: _____
(line a + line b)
- Check the box that matches your home's construction type, number of stories, and total floor area. You will use information in this row of the schedule to determine length of wood structural panels, nailing requirements, quantities of hardware, etc.
- Measure the maximum height of the cripple wall along each wall line of the house.
- Determine the length of wood structural panel bracing required. The columns contain the length of required bracing, depending on the height of the cripple wall. The length of bracing is given for cripple wall heights of zero to 1', 1' to 2', 2' to 4', 4' to 6', and 6' to 7'. Furthermore, choices are given for bracing without tie-downs and with tie-downs. If the cripple wall height changes along the length of the wall, use the tallest height to determine the required bracing length. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for the cripple wall height on each side of the house. Review General Notes, Sheet S1, Section J for instructions at non-rectangular "T" or "L" shaped dwellings. Check boxes where Special Provisions apply.
- Determine the number of Foundation Sill Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or 1/2"Ø or 5/8"Ø anchor bolts. (Ø = diameter of the bolts.) See Sheet S3.
- Determine the number of Floor to Cripple Wall or Foundation Sill connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
- Complete the Retrofit Summary for your project. Fill in the lengths of Wood Structural Panels found in ⑤. Fill in the type and quantity of anchors used on each wall line. The length of new cripple wall sheathing should be distributed along a wall line either in one full length or in a maximum of two panel lengths of approximately equal length (offset walls can have three). If you intend to use tie-downs, check the box for tie-downs for each wall line where use is intended. Check the box on line 5, and read the Supplemental Technical Notes for additional information. Where the length of required panel does not fit within the available length, the dwelling must have an engineered solution. Alternately, if 100% of the length along any particular wall can be sheathed, then that wall line shall be considered acceptable and an engineered solution is not required.

Notes:

- Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that where using 1/2" or 5/8" bolts, one additional anchor is required at the end of each braced wall panel per Sheet D4.
- Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
- Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
- Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
- This Plan Set was developed using the _____ listed _____ capacity _____ Required number of connectors on the Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be designed or specified by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

RETROFIT SUMMARY BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

- Minimum required length of Wood Structural Panels per wall line: (check boxes where condition applies)
North Wall _____ ft x2 with tie-downs with Special Provisions
East Wall _____ ft x2 with tie-downs with Special Provisions
South Wall _____ ft x2 with tie-downs with Special Provisions
West Wall _____ ft x2 with tie-downs with Special Provisions
- Panel Edge Nailing _____" on center.
- New Foundation Sill Anchorage:
North Wall Type: _____ Min required: _____ Additional types/quantity (if used):
East Wall Type: _____ Min required: _____ Type: _____ Min required: _____
South Wall Type: _____ Min required: _____ Type: _____ Min required: _____
West Wall Type: _____ Min required: _____ Type: _____ Min required: _____
- Floor Framing Connectors (to Cripple Wall or Foundation Sill): Additional types/quantity (if used):
North Wall Type: _____ Min required: _____ Type: _____ Min required: _____
East Wall Type: _____ Min required: _____ Type: _____ Min required: _____
South Wall Type: _____ Min required: _____ Type: _____ Min required: _____
West Wall Type: _____ Min required: _____ Type: _____ Min required: _____
- Check this box if tie-downs and SUPPLEMENTAL TECHNICAL NOTES on Sheet S2 will be used.

APPLICANT: _____
PROPERTY ADDRESS: _____

Earthquake Retrofit Schedule
S_{DS} = 1.2 Two-Story

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of
One- and Two-Family Dwellings

Date: _____

Sheet: _____

S3.1

EARTHQUAKE RETROFIT SCHEDULE (S_{Ds}= 1.5 Very High Seismic) TWO-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies <input checked="" type="checkbox"/>	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length								
			Wood Structural Panels								⑥ Foundation Sill Anchors			⑦ Floor to Cripple Wall or Floor to Foundation Sill					
			④ Cripple Wall Height								Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"ø Bolt	5/8"ø Bolt	Type "D"	Type "E" or "F"	Type "G"
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"	4'-1" to 6'-0"	6'-1" to 7'-0"	Without Tie-downs	With Tie-downs	Without Tie-downs									
2-Story Light Construction	up to 1600		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	15	17	17	11	26	25	32
	1601 to 2000		13.3'	13.3'	16.0'	13.3'	18.7'	14.7'	20.0'	16.0'	4"	11	18	20	19	13	30	29	38
	2001 to 2400		14.7'	16.0'	17.3'	16.0'	21.3'	16.0'	22.7'	17.3'	4"	13	20	22	22	15	34	33	43
	2401 to 3000		18.7'	18.7'	20.0'	18.7'	22.7'	18.7'	24.0'	18.7'	4"	15	24	26	26	18	41	39	51
	3001 to 4000		22.7'	22.7'	22.7'	22.7'	26.7'	24.0'	28.0'	24.0'	4"	19	30	33	33	22	50	48	64
2-Story Medium Construction	up to 1600		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	11	17	18	18	13	28	27	36
	1601 to 2000		12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	3"	13	20	22	22	15	33	32	42
	2001 to 2400		13.3'	14.7'	18.7'	13.3'	21.3'	16.0'	22.7'	17.3'	3"	14	23	25	25	17	38	37	48
	2401 to 3000		16.0'	17.3'	20.0'	16.0'	22.7'	18.7'	24.0'	20.0'	3"	17	27	29	29	20	45	43	58
	3001 to 4000		20.0'	20.0'	22.7'	20.0'	26.7'	21.3'	28.0'	22.7'	3"	21	34	37	37	25	57	54	72
2-Story Heavy Construction	up to 1600		12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	35	34	45
	1601 to 2000		13.3'	14.7'	17.3'	14.7'	20.0'	16.0'	21.3'	17.3'	2"	16	25	27	27	19	42	40	53
	2001 to 2400		14.7'	16.0'	20.0'	16.0'	22.7'	18.7'	24.0'	18.7'	2"	18	28	31	31	21	48	46	61
	2401 to 3000		16.0'	18.7'	21.3'	17.3'	24.0'	20.0'	25.3'	21.3'	2"	21	34	37	37	25	57	55	72
	3001 to 4000		18.7'	21.3'	25.3'	20.0'	28.0'	24.0'	29.3'	25.3'	2"	27	42	46	46	31	71	68	90

INSTRUCTIONS

1. Locate the section that matches your home's construction. Use the chart on Sheet S3 to determine "Weight Category".
2. Find the home's Total Floor Area in the schedule, this number should be at least as large as the number calculated in 2.c. Do not use a smaller number, even if it is closer.
 - a. Approximate 1st floor area over crawl space: _____ (Do not include areas built over slab-on-grade.)
 - b. Approximate 2nd floor area over crawl space: _____ (Do not include areas where the 1st floors over slab-on-grade.)
 - c. Total approximate square footage: _____ (line a + line b)
3. Check the box that matches your home's construction type, number of stories, and total floor area. You will use information in this row of the schedule to determine length of wood structural panels, nailing requirements, quantities of hardware, etc.
4. Measure the maximum height of the cripple wall along each wall line of the house.
5. Determine the length of wood structural panel bracing required. The columns contain the length of required bracing, depending on the height of the cripple wall. The length of bracing is given for cripple wall heights of zero to 1', 1' to 2', 2' to 4', 4' to 6', and 6' to 7'. Furthermore, choices are given for bracing without tie-downs and with tie-downs. If the cripple wall height changes along the length of the wall, use the tallest height to determine the required bracing length. Follow the row across from the total floor area that you checked for your home (in Step 3) to find the bracing length for the cripple wall height on each side of the house. Review General Notes, Sheet S1, Section J for instructions at non-rectangular "T" or "L" shaped dwellings. Check boxes where Special Provisions apply.
6. Determine the number of Foundation Sill Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or 1/2"ø or 5/8"ø anchor bolts. (ø = diameter of the bolts.) See Sheet S3.
7. Determine the number of Floor to Cripple Wall or Foundation Sill connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
8. Complete the Retrofit Summary for your project. Fill in the lengths of Wood Structural Panels found in 5. Fill in the type and quantity of anchors used on each wall line. The length of new cripple wall sheathing should be distributed along a wall line either in one full length or in a maximum of two panel lengths of approximately equal length (offset walls can have three). If you intend to use tie-downs, check the box for tie-downs for each wall line where use is intended. Check the box on line 5, and read the Supplemental Technical Notes for additional information. Where the length of required panel does not fit within the available length, the dwelling must have an engineered solution. Alternately, if 100% of the length along any particular wall can be sheathed, then that wall line shall be considered acceptable and an engineered solution is not required.

⑧ RETROFIT SUMMARY
BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Minimum required length of Wood Structural Panels per wall line: (check boxes where condition applies)

North Wall _____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
East Wall _____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
South Wall _____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
West Wall _____ ft x2	<input type="checkbox"/> with tie-downs	<input type="checkbox"/> with Special Provisions
2. Panel Edge Nailing _____" on center.
3. New Foundation Sill Anchorage:

North Wall Type: _____ Min required: _____	Additional types/quantity (if used): Type: _____ Min required: _____
East Wall Type: _____ Min required: _____	Type: _____ Min required: _____
South Wall Type: _____ Min required: _____	Type: _____ Min required: _____
West Wall Type: _____ Min required: _____	Type: _____ Min required: _____
4. Floor Framing Connectors (to Cripple Wall or Foundation Sill):

North Wall Type: _____ Min required: _____	Additional types/quantity (if used): Type: _____ Min required: _____
East Wall Type: _____ Min required: _____	Type: _____ Min required: _____
South Wall Type: _____ Min required: _____	Type: _____ Min required: _____
West Wall Type: _____ Min required: _____	Type: _____ Min required: _____
5. Check this box if tie-downs and SUPPLEMENTAL TECHNICAL NOTES on Sheet S2 will be used.

Notes:

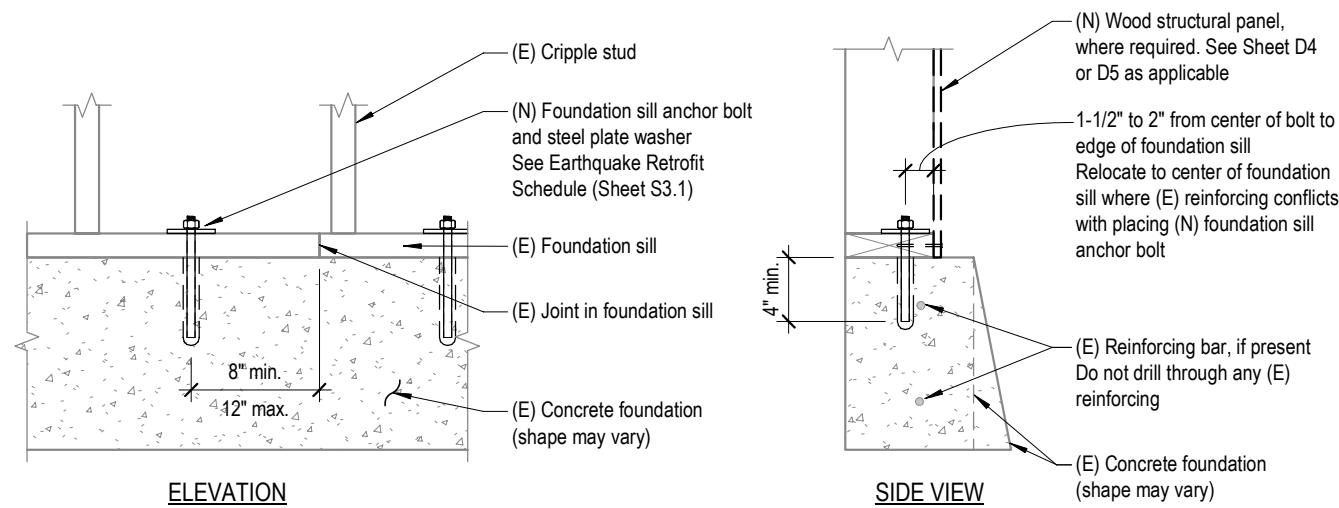
1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that where using 1/2" or 5/8" bolts, one additional anchor is required at the end of each braced wall panel per Sheet D4.
2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
3. Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
4. Any of the connectors listed within a particular group and as shown on Sheet S3 may be used for strengthening the particular condition.
5. This Plan Set was developed using the _____ listed _____ capacity _____. Required number of connectors on the Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be designed or specified by a Registered Design Professional.
6. Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Date: _____
Sheet: _____

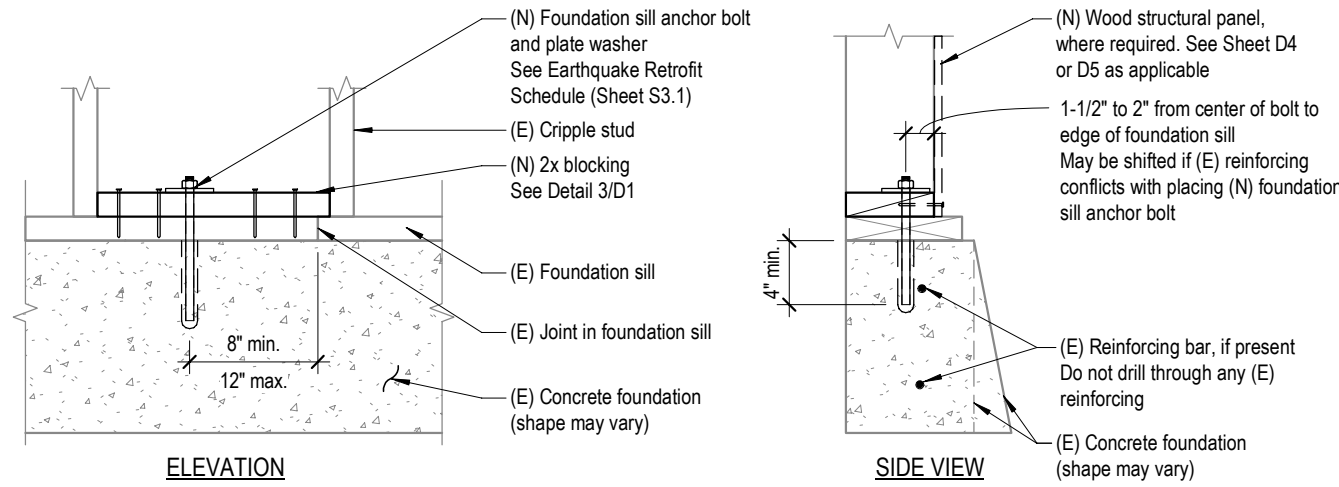
S3.1

Earthquake Retrofit Schedule
S_{Ds} = 1.5 Two-Story
Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

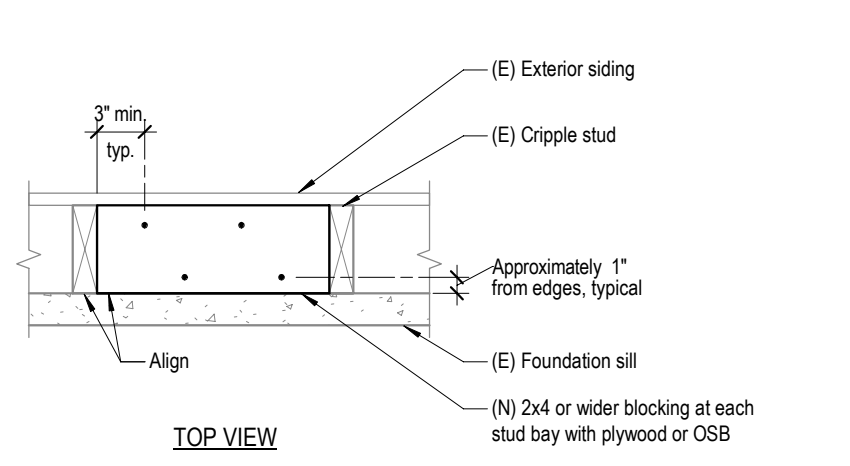
APPLICANT: _____
PROPERTY ADDRESS: _____



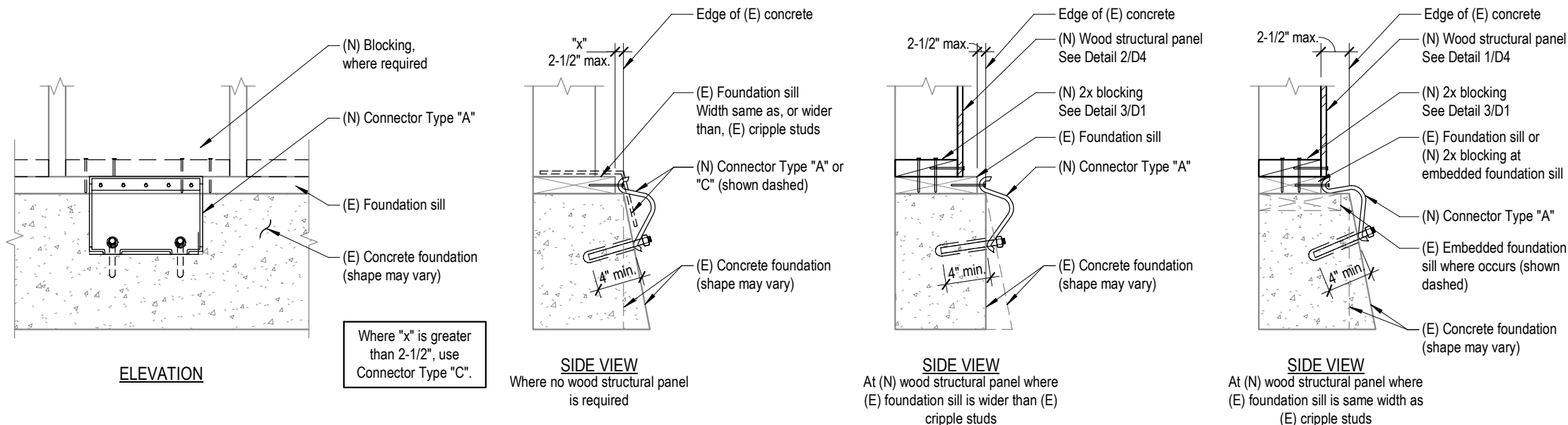
1 ANCHOR THROUGH FOUNDATION SILL ONLY
Detail applies where (E) foundation sill is the same width as the (E) cripple studs



2 ANCHOR THROUGH BLOCKING AND FOUNDATION SILL
Detail applies where (E) foundation sill is wider than the (E) cripple studs



3 NEW BLOCKING INSTALLATION FOR SHEATHING ATTACHMENT
At each stud bay with sheathing



4 FOUNDATION SILL CONNECTORS
Detail used where cripple wall studs are too short to allow drilling for new anchor bolts. Maximum cripple wall height 2'-0\"/>

MATERIAL KEY:	
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:	
Term	Description
Nails	
8d (8 penny) at connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at connectors attached over plywood	0.148" x 3" long
10d (10 penny) at connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Structural wood screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood structural panel	15/32" Plywood sheathing. Exposure rating of Exterior or Exposure I. 4- or 5-Ply. or Oriented Strand Board (OSB) Conforming to US Voluntary Product Standard PS 2. Exposure rating of Exterior or Exposure I. Manufactured with exterior glue. Minimum 4-ply.
LVL (laminated veneer lumber)	
Plate washer	3" x 3" square x 0.229" thick.
"Peel & Stick" flashing tape bituthene	
For Connector types see Sheet S3.	

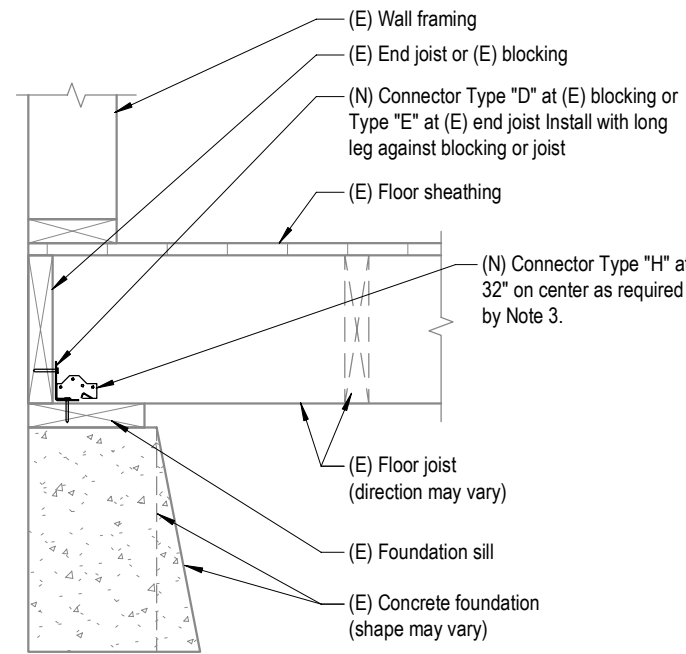
ABBREVIATIONS	
(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

APPLICANT: _____
PROPERTY ADDRESS: _____

Foundation Sill to Concrete Foundation Connection Details

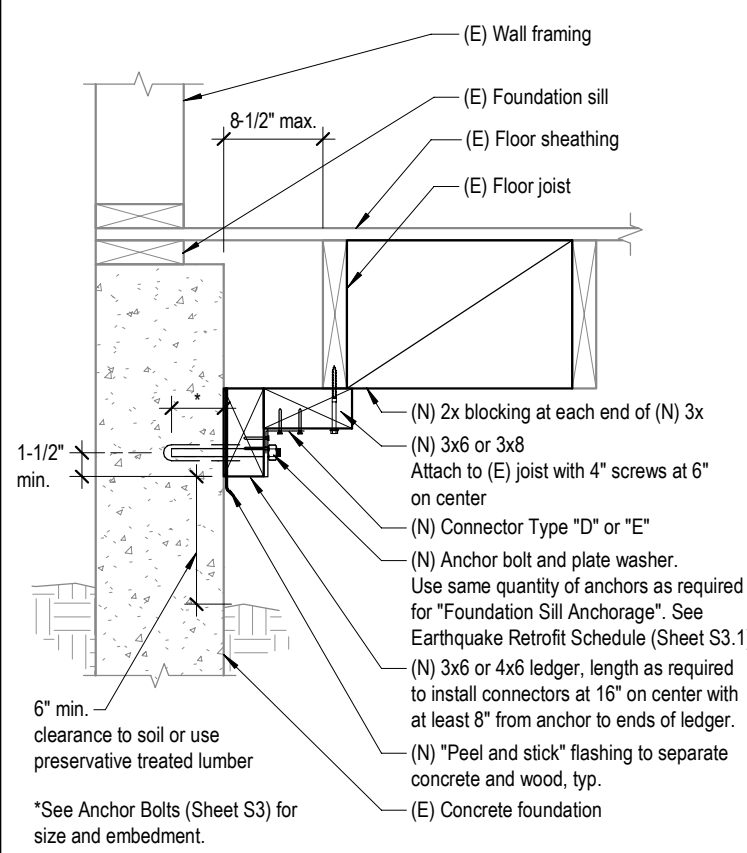
Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D1**

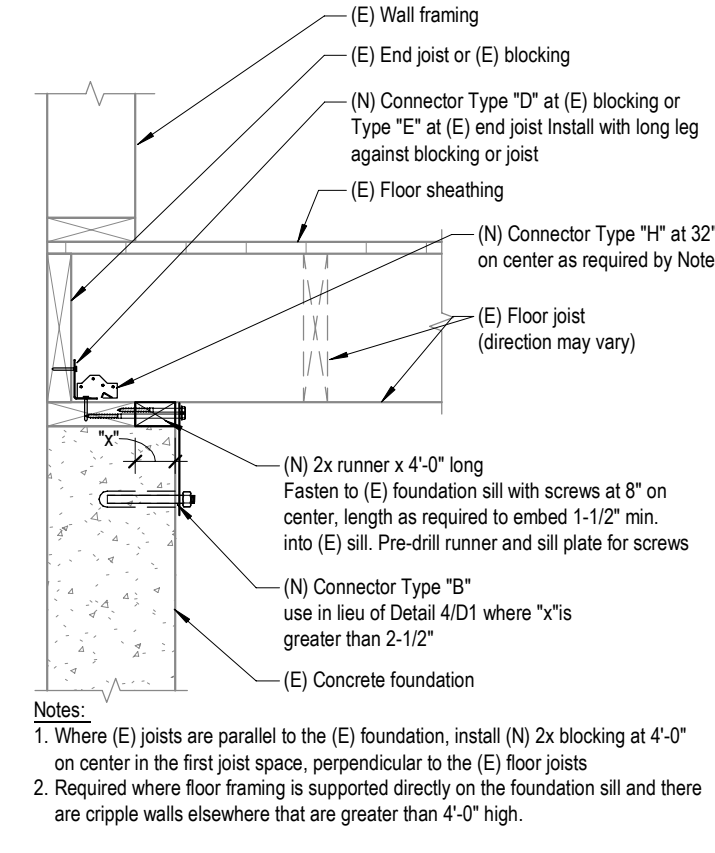


- Notes:**
1. See Sheet D1 for foundation sill to concrete foundation details.
 2. Where (E) joists are parallel to the (E) foundation, install (N) 2x blocking at 4'-0" on center in the first joist space perpendicular to the (E) floor joists.
 3. Required where floor framing is supported directly on the foundation sill and there are cripple walls elsewhere that are greater than 4'-0" high.

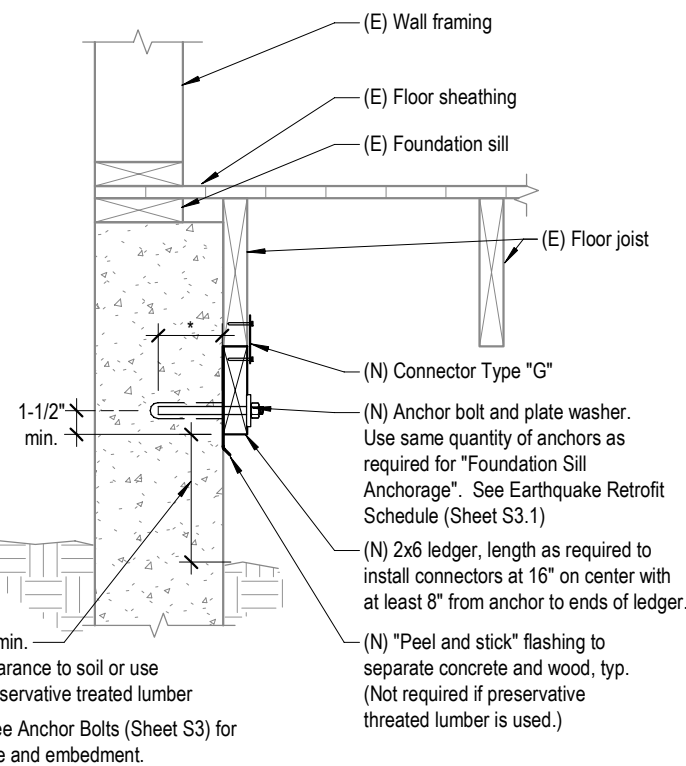
1 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION



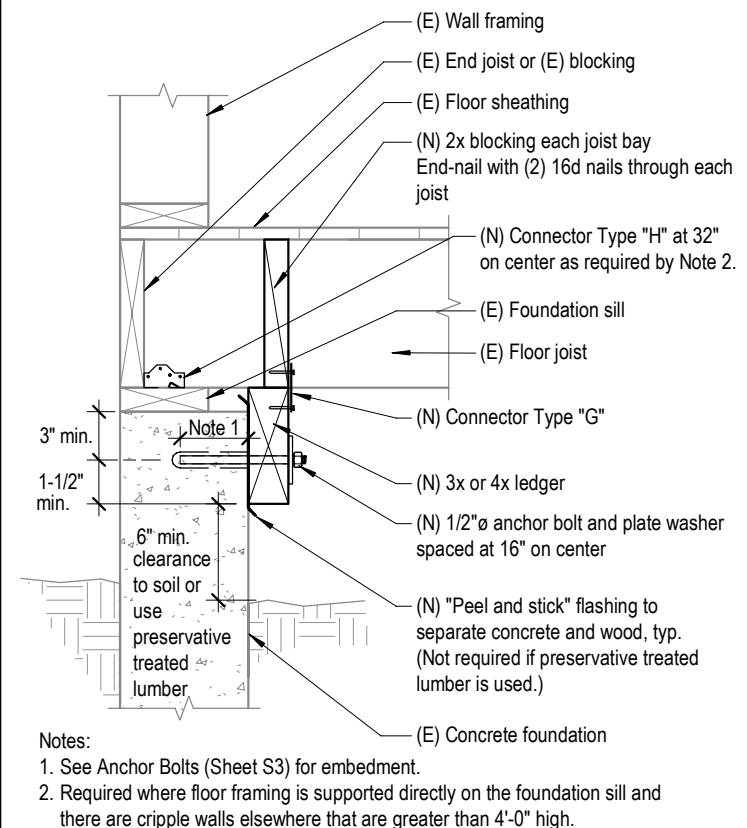
2 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION



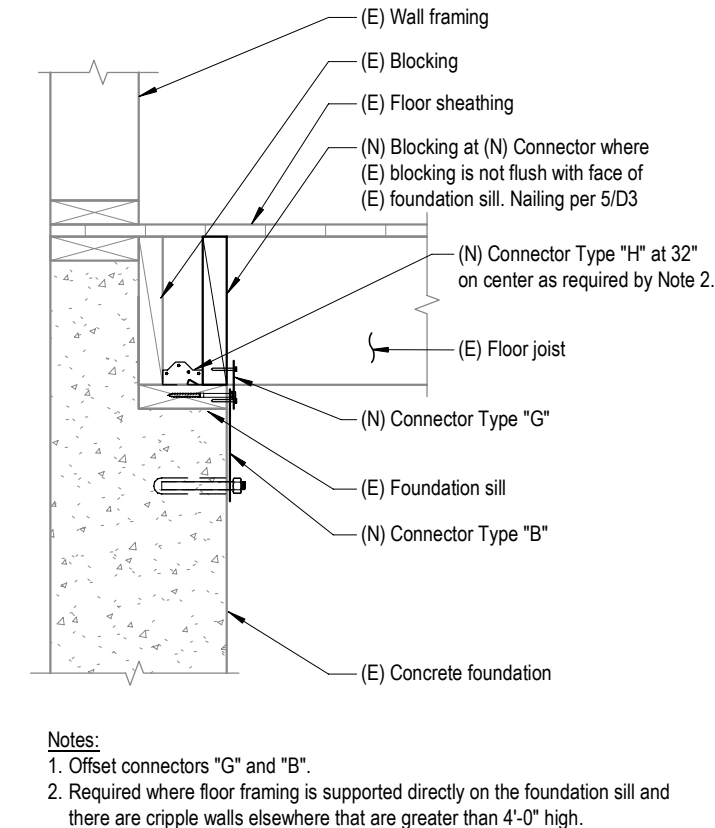
3 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION



4 FLOOR FRAMING-TO-NEW LEDGER CONNECTION



5 FLOOR FRAMING-TO-NEW LEDGER CONNECTION



6 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION

MATERIAL KEY:

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Term	Description
Nails	
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3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood structural panel	15/32" Plywood sheathing. Exposure rating of Exterior or Exposure I. 4- or 5-Ply. or Oriented Strand Board (OSB) Conforming to US Voluntary Product Standard PS 2. Exposure rating of Exterior or Exposure I. Manufactured with exterior glue. Minimum 4-ply.
LVL (laminated veneer lumber)	
Plate washer	3" x 3" square x 0.229" thick.
"Peel & Stick" flashing tape bituthene	
For Connector types see Sheet S3.	

ABBREVIATIONS

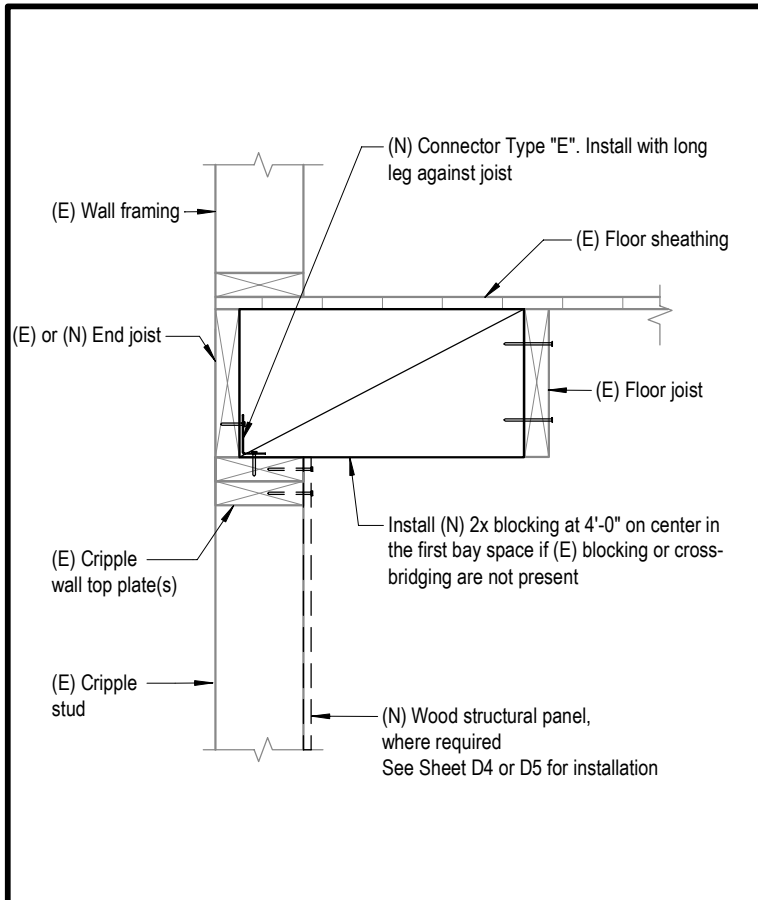
(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

APPLICANT: _____
PROPERTY ADDRESS: _____

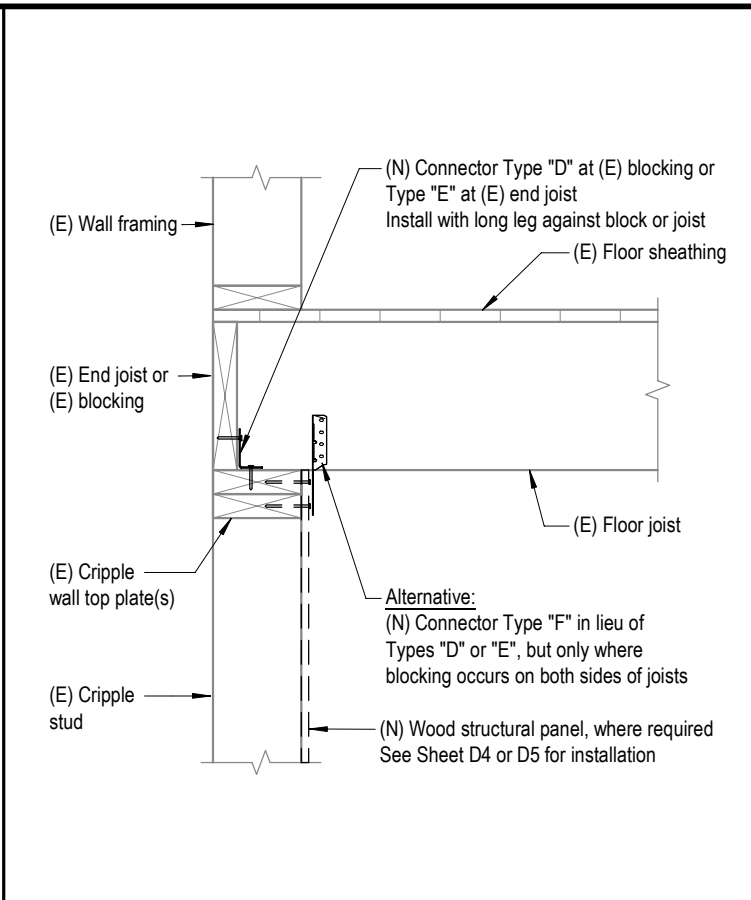
Floor Framing to Foundation Sill Connection Details

Retrofit of Crawlspaces Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

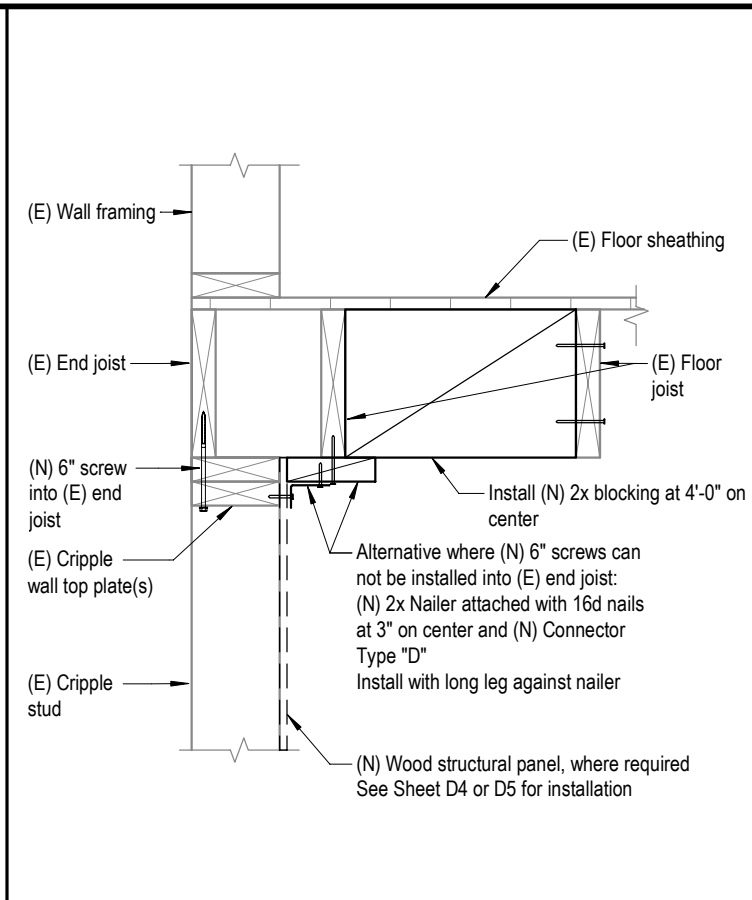
Date: _____
Sheet: **D2**



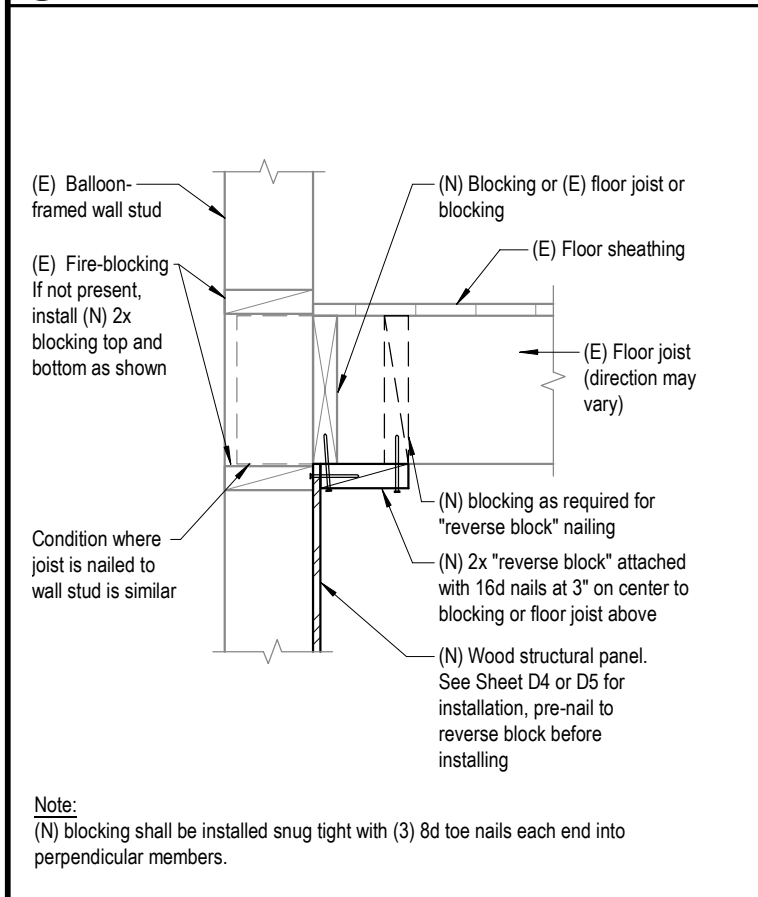
1 FLOOR-TO-CRIPPLE WALL CONNECTION AT PARALLEL JOISTS



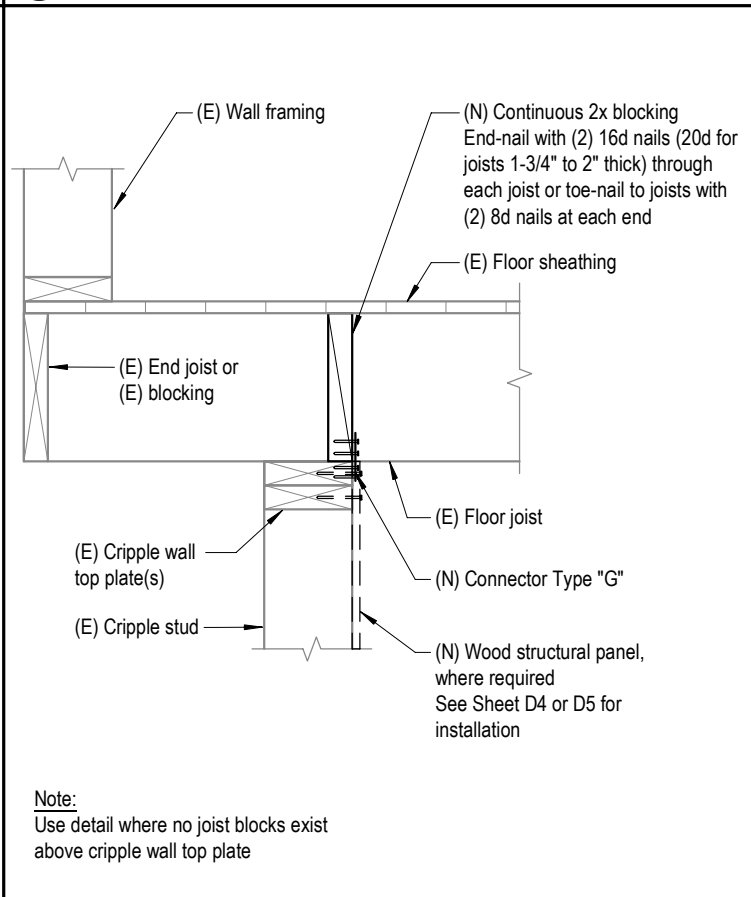
2 FLOOR-TO-CRIPPLE WALL CONNECTION AT PERPENDICULAR JOISTS



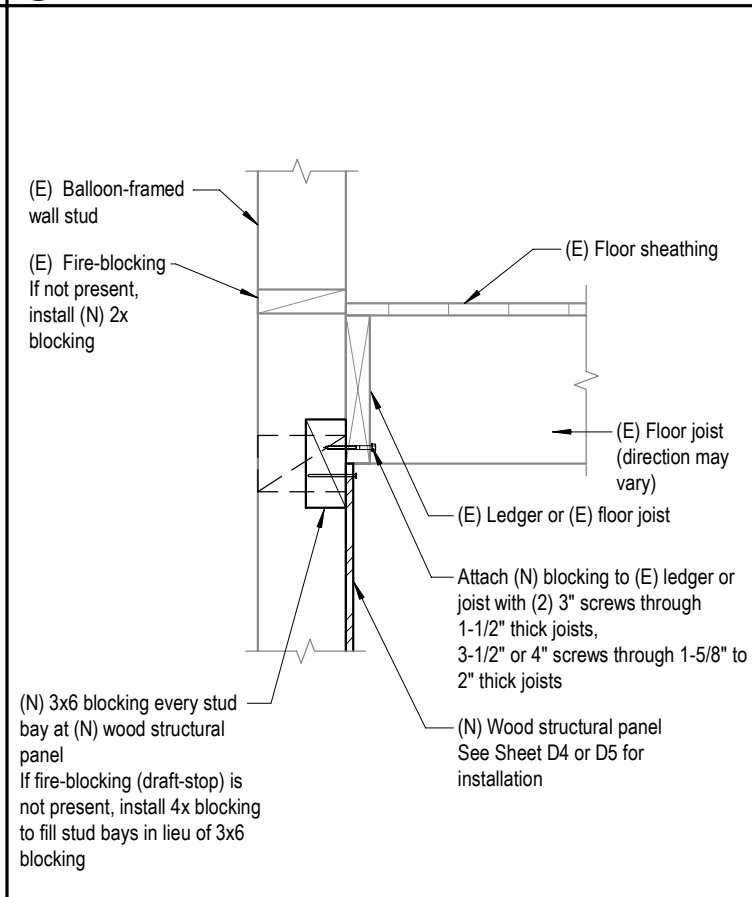
3 FLOOR-TO-CRIPPLE WALL CONNECTION WHERE END JOIST IS NOT ACCESSIBLE



4 FLOOR-TO-CRIPPLE WALL CONNECTION AT BALLOON-FRAMED WALLS



5 FLOOR-TO-CRIPPLE WALL CONNECTION AT FLOOR OVERHANG



6 FLOOR-TO-CRIPPLE WALL CONNECTION

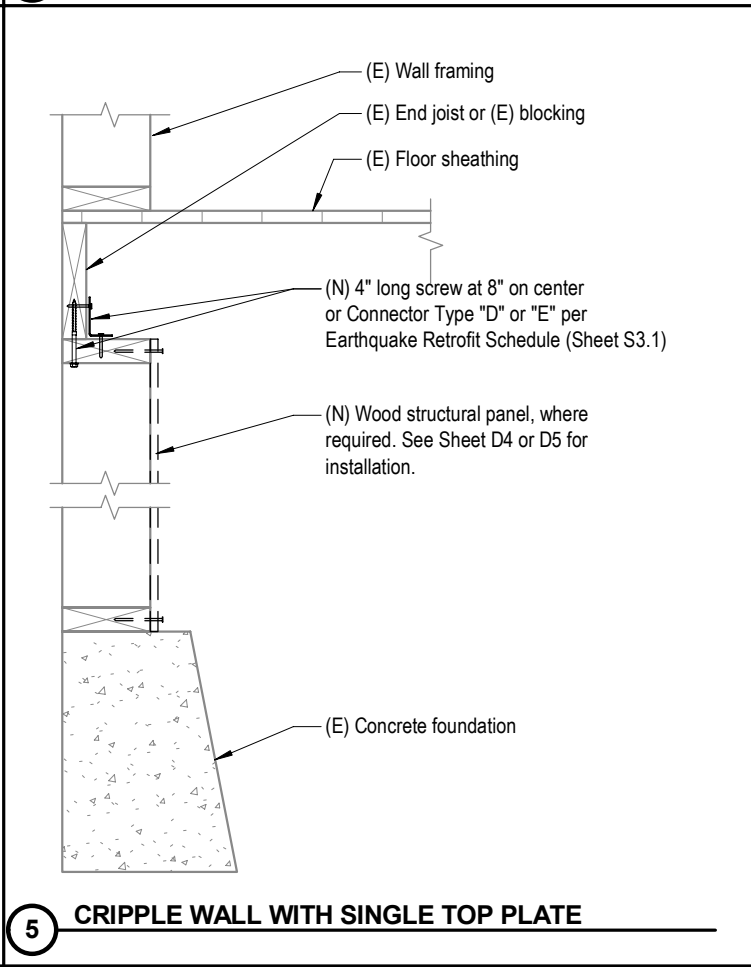
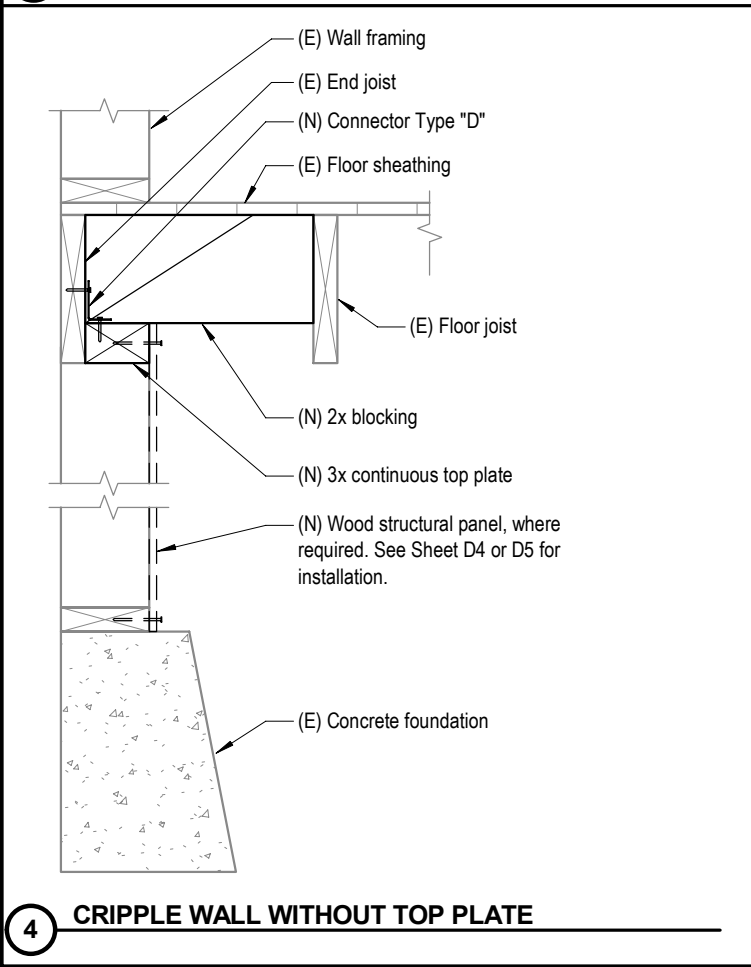
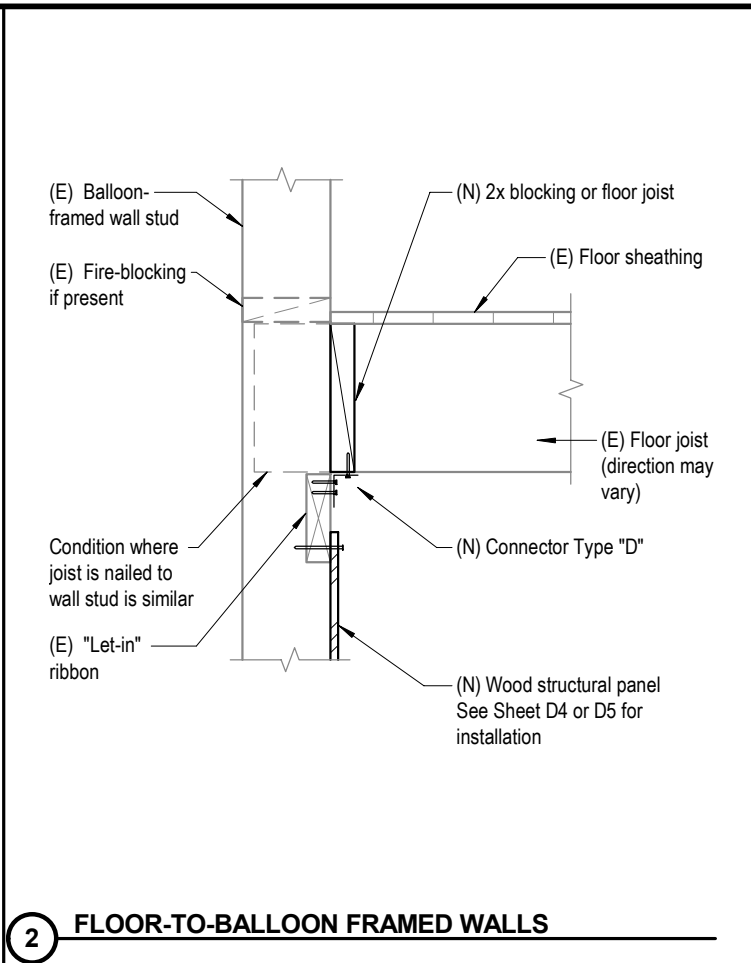
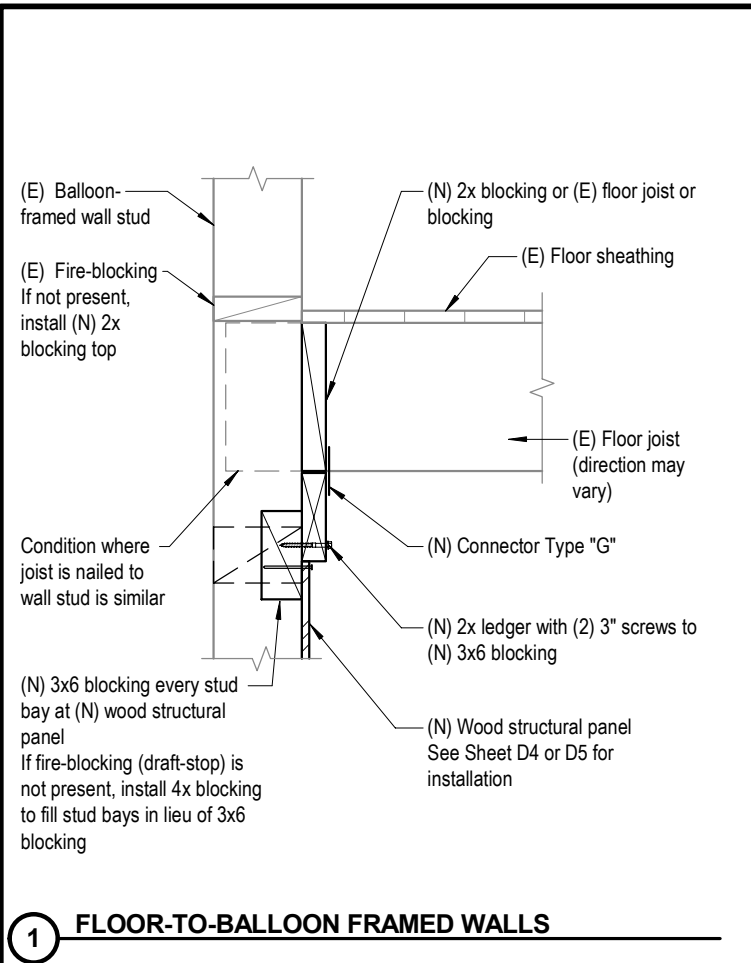
MATERIAL KEY:	
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LVL (laminated veneer lumber)	
Plate washer	3" x 3" square x 0.229" thick.
"Peel & Stick" flashing tape bituthene	
For Connector types see Sheet S3.	
ABBREVIATIONS	
(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

APPLICANT: _____
PROPERTY ADDRESS: _____

Floor Framing to Cripple Wall Connection Details

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D3**



MATERIAL KEY:
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Nails	
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LVL (laminated veneer lumber)	
Plate washer	3" x 3" square x 0.229" thick.
"Peel & Stick" flashing tape bituthene	

ABBREVIATIONS

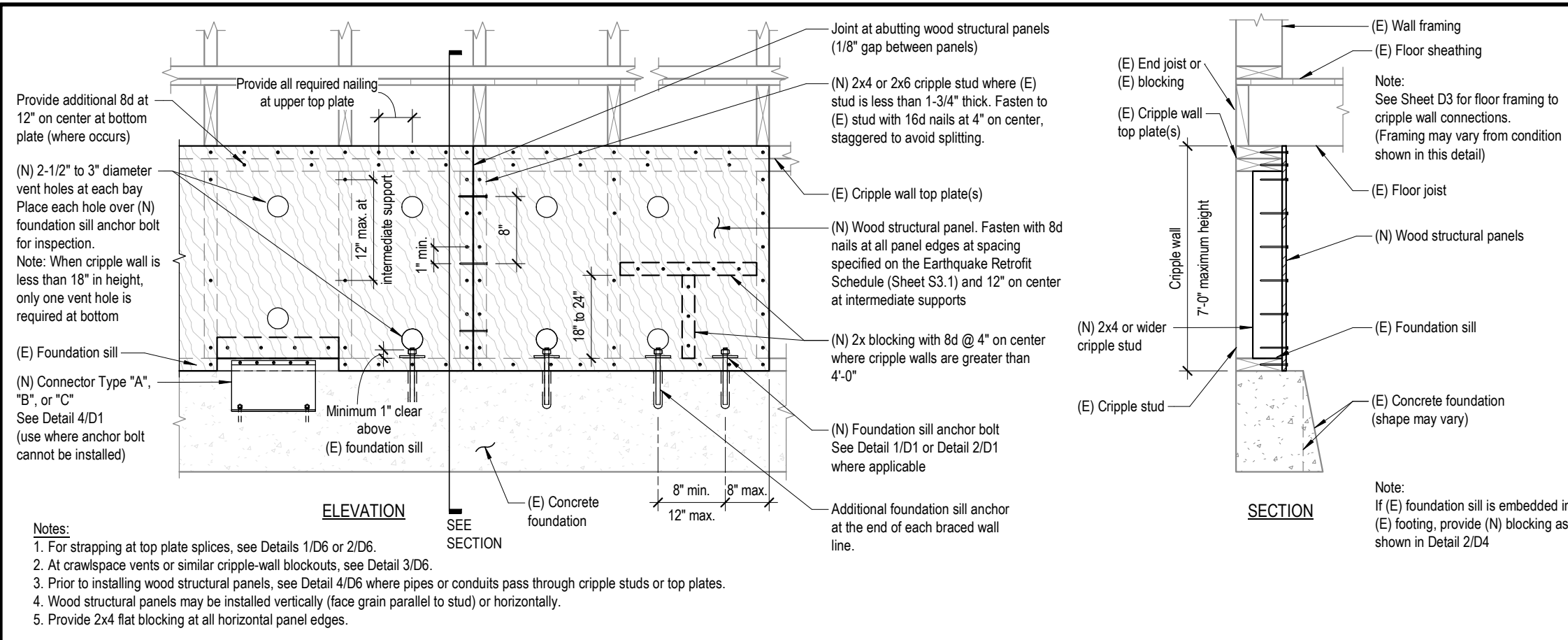
(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

APPLICANT: _____
PROPERTY ADDRESS: _____

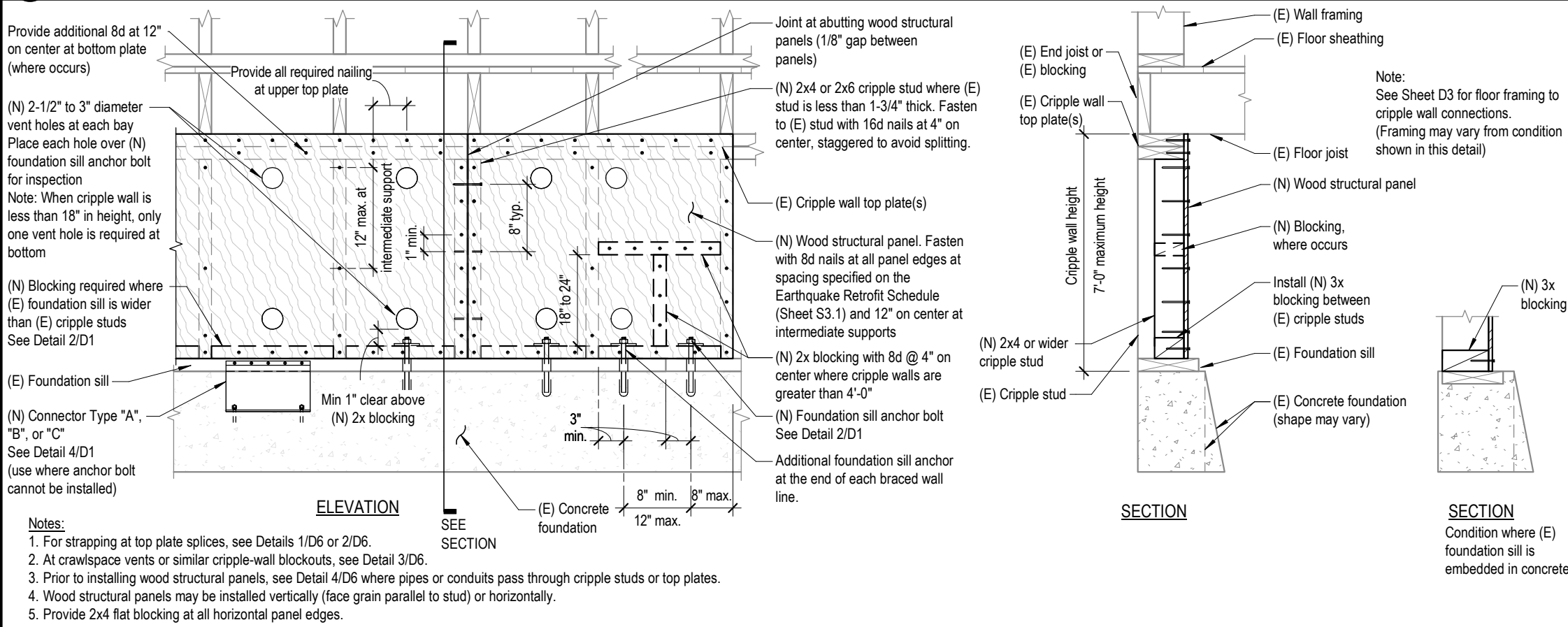
Floor Framing to Cripple Wall Connection Details

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D3.1**



1 FOUNDATION SILL SAME WIDTH AS CRIPPLE WALL



2 FOUNDATION SILL WIDER THAN CRIPPLE WALL

MATERIAL KEY:
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

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8d (8 penny) at connectors attached directly to framing	0.131" x 1-1/2" long
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LVL (laminated veneer lumber)	
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"Peel & Stick" flashing tape bituthene	
For Connector types see Sheet S3.	

ABBREVIATIONS

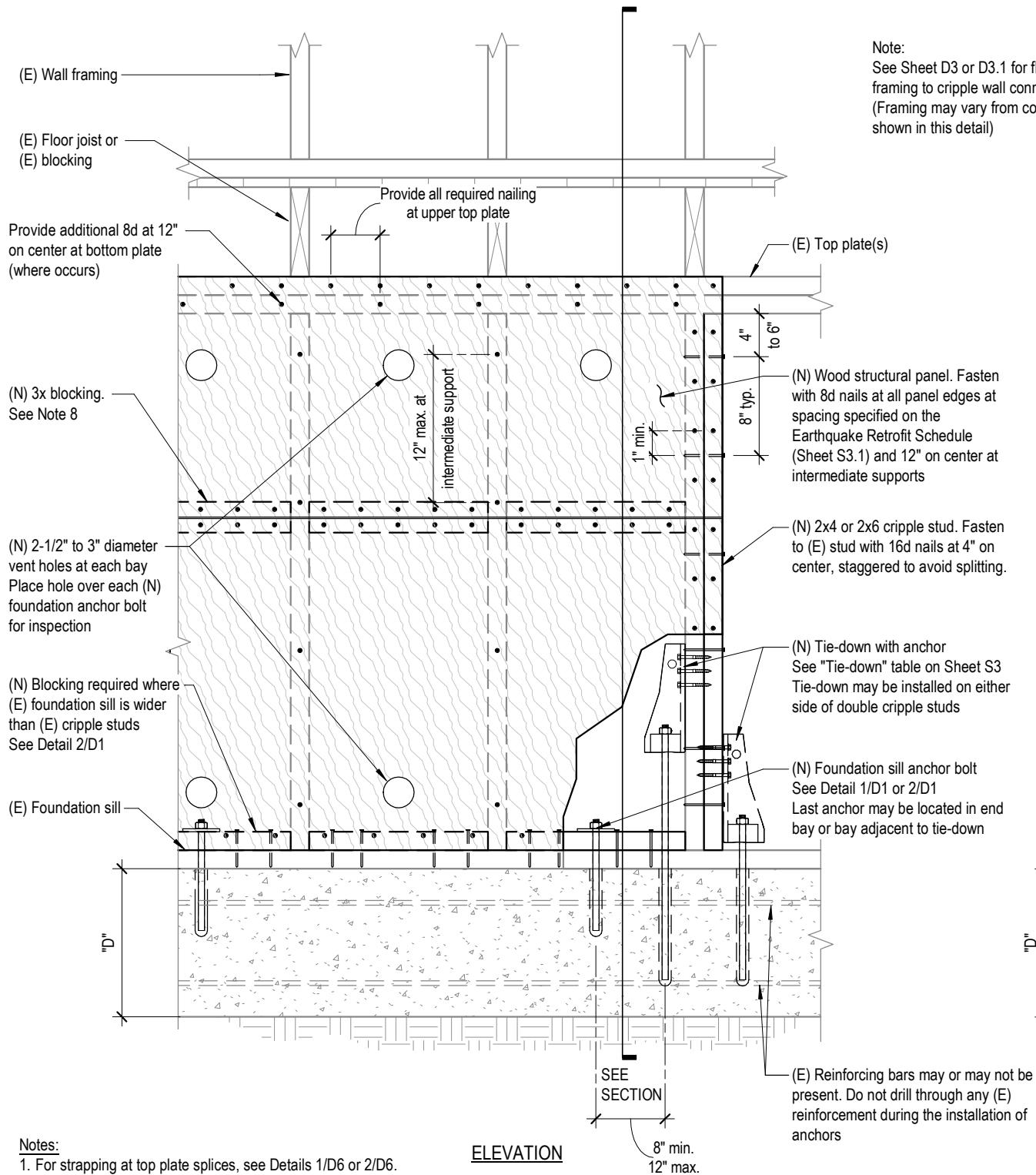
(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

APPLICANT: _____
PROPERTY ADDRESS: _____

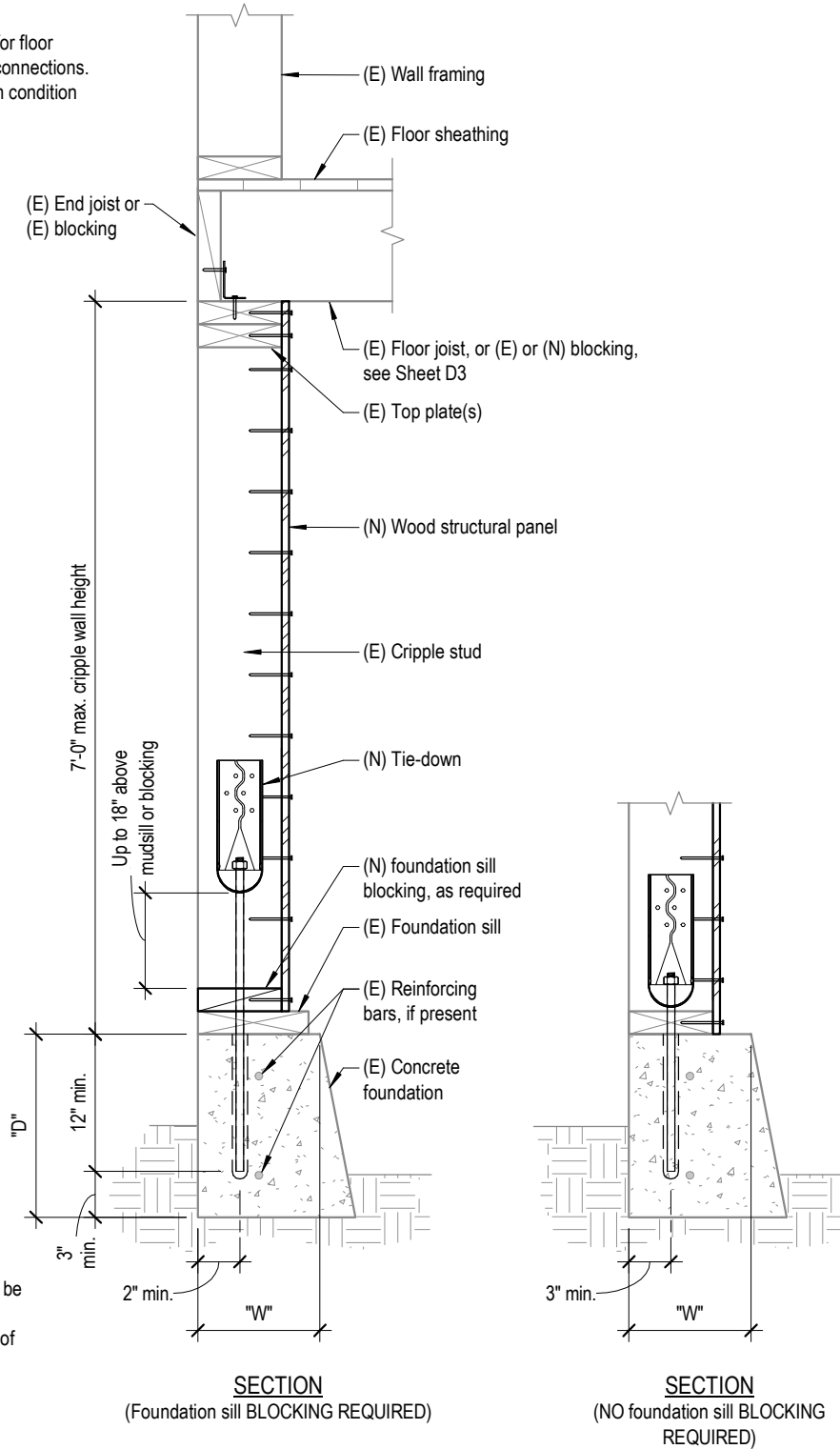
Wood Structural Panel Installation without Tie-Downs

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____
Sheet: **D4**



Note:
See Sheet D3 or D3.1 for floor framing to cripple wall connections. (Framing may vary from condition shown in this detail)



- Notes:
1. For strapping at top plate splices, see Details 1/D6 or 2/D6.
 2. At crawlspace vents or similar cripple-wall blockouts, see Detail 3/D6.
 3. Prior to installing wood structural panels, see Detail 4/D6 where pipes or conduits pass through cripple studs or top plates.
 4. "W" indicates the width of an existing foundation, or new foundation constructed in accordance with Detail 1/D7.
 5. "D" indicates the depth of an existing foundation, or new foundation constructed in accordance with Detail 1/D7.
 6. For existing foundations, see Supplemental Technical Notes, Sheet S2, Section R for additional requirements.
 7. Wood structural panels may be installed vertically (face grain parallel to stud) or horizontally.
 8. Provide 2x4 flat blocking at all horizontal panel edges.

1 TYPICAL INSTALLATION

MATERIAL KEY:	
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:	
Term	Description
Nails	
8d (8 penny) at connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at connectors attached over plywood	0.148" x 3" long
10d (10 penny) at connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Structural wood screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood structural panel	15/32" Plywood sheathing. Exposure rating of Exterior or Exposure I. 4- or 5-Ply. or Oriented Strand Board (OSB) Conforming to US Voluntary Product Standard PS 2. Exposure rating of Exterior or Exposure I. Manufactured with exterior glue. Minimum 4-ply.
LVL (laminated veneer lumber)	
Plate washer	3" x 3" square x 0.229" thick.
"Peel & Stick" flashing tape bituthene	
For Connector types see Sheet S3.	

ABBREVIATIONS

- (E) Existing
- (N) New
- min. Minimum
- max. Maximum
- NTS Not to Scale
- typ. Typical

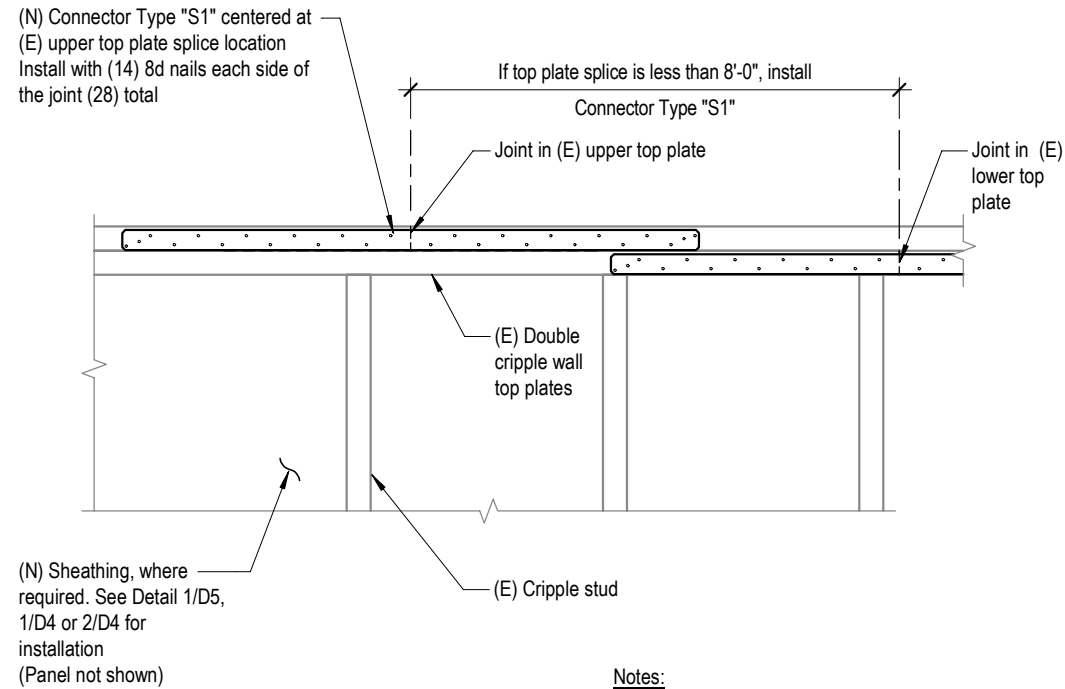
APPLICANT: _____
PROPERTY ADDRESS: _____

Wood Structural Panel Installation with Tie-Downs

Retrofit of Crawlspace Dwellings (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

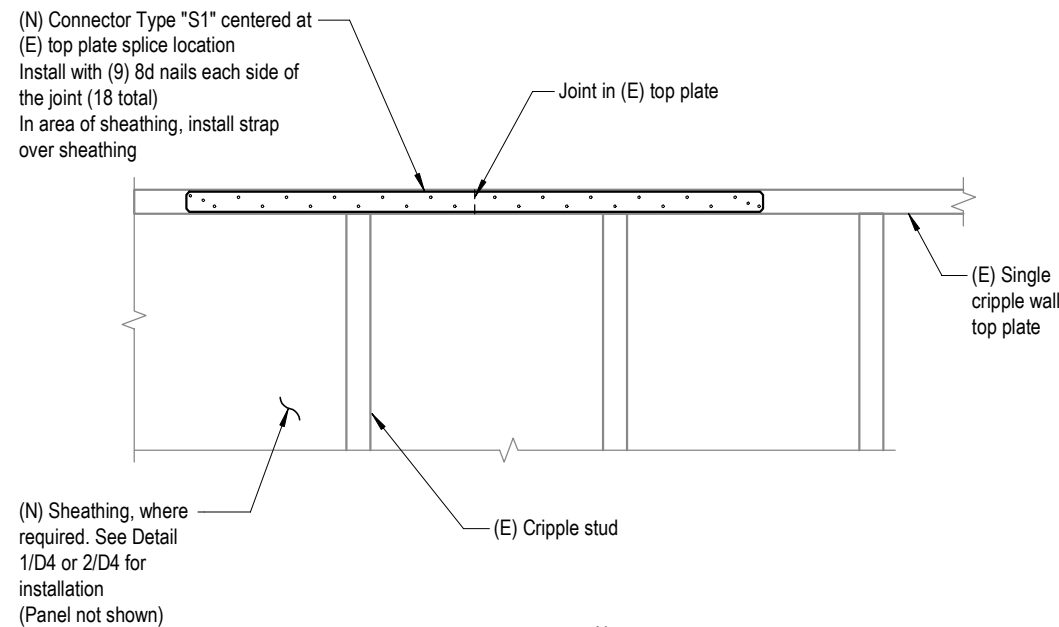
Date: _____

Sheet: _____



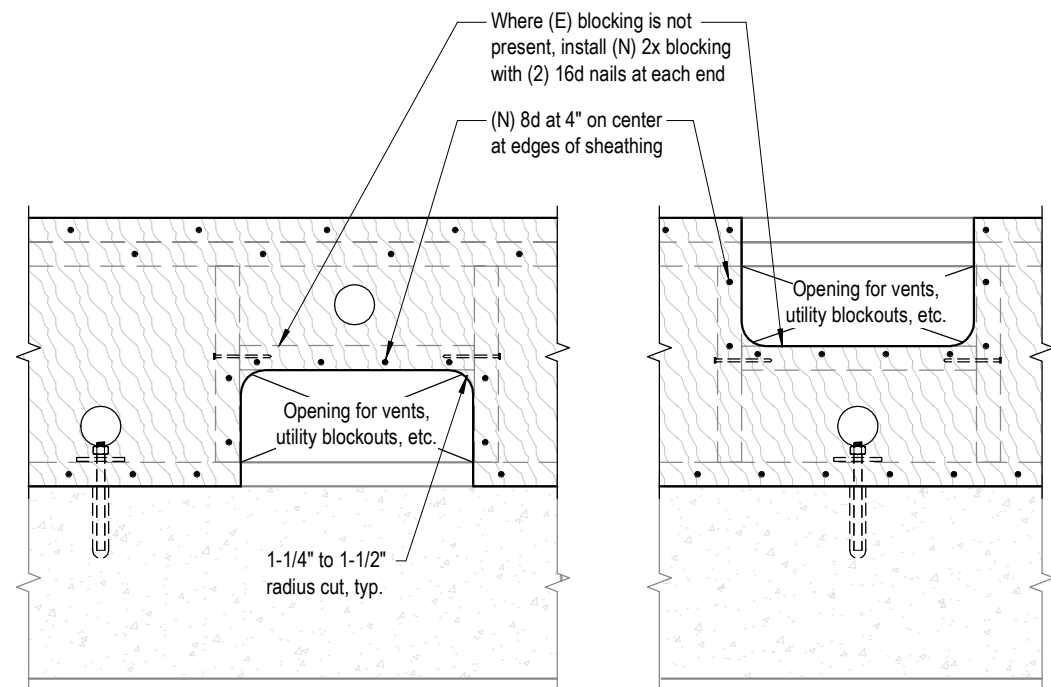
- Notes:**
 1. Floor framing not shown for clarity.
 2. In area of sheathing, install strap over sheathing.

1 TOP PLATE SPLICE AT EXISTING DOUBLE TOP PLATES



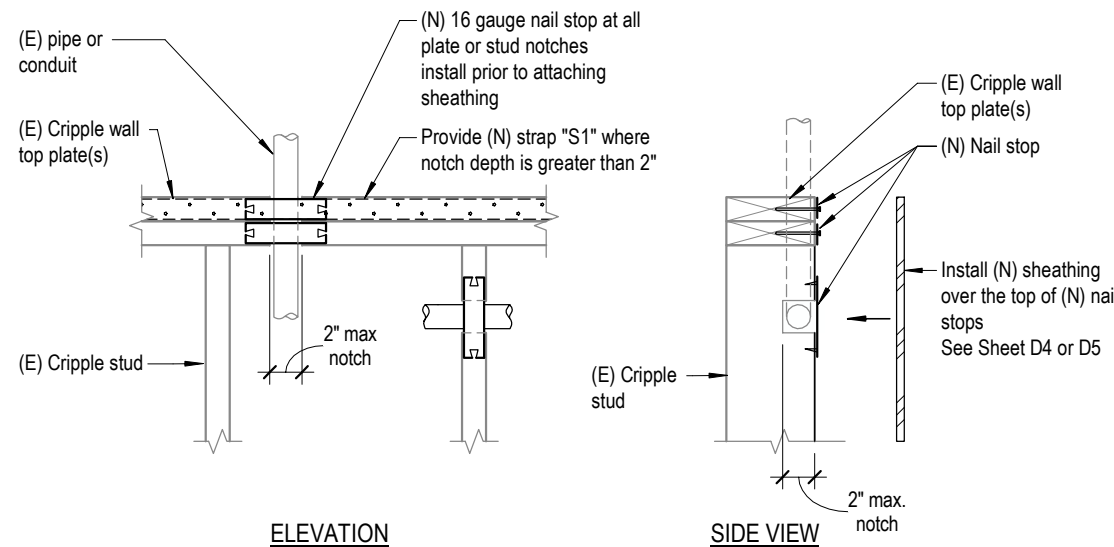
- Notes:**
 1. Floor framing not shown for clarity.
 2. In area of sheathing, install strap over sheathing.

2 TOP PLATE SPLICE AT EXISTING SINGLE TOP PLATE



- Notes:**
 1. Do not cover existing vents.
 2. Increase wood structural panel length a distance equal to the length of blockout(s) or one stud bay width whichever is greater.

3 CUTOUT REQUIREMENTS IN BRACED PANELS



- Note:**
 1. Floor framing not shown.

4 ALLOWABLE NOTCHING AND REINFORCING FOR TOP PLATES AND STUDS

MATERIAL KEY:
 Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at connectors attached over plywood	0.148" x 3" long
10d (10 penny) at connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long

Structural wood screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw

Wood structural panel	15/32" Plywood sheathing. Exposure rating of Exterior or Exposure I. 4- or 5-Ply. or Oriented Strand Board (OSB) Conforming to US Voluntary Product Standard PS 2. Exposure rating of Exterior or Exposure I. Manufactured with exterior glue. Minimum 4-ply.
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LVL (laminated veneer lumber)	
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Plate washer	3" x 3" square x 0.229" thick.
--------------	--------------------------------

"Peel & Stick" flashing tape bituthene	
--	--

For Connector types see Sheet S3.

ABBREVIATIONS

(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

APPLICANT: _____
 PROPERTY ADDRESS: _____

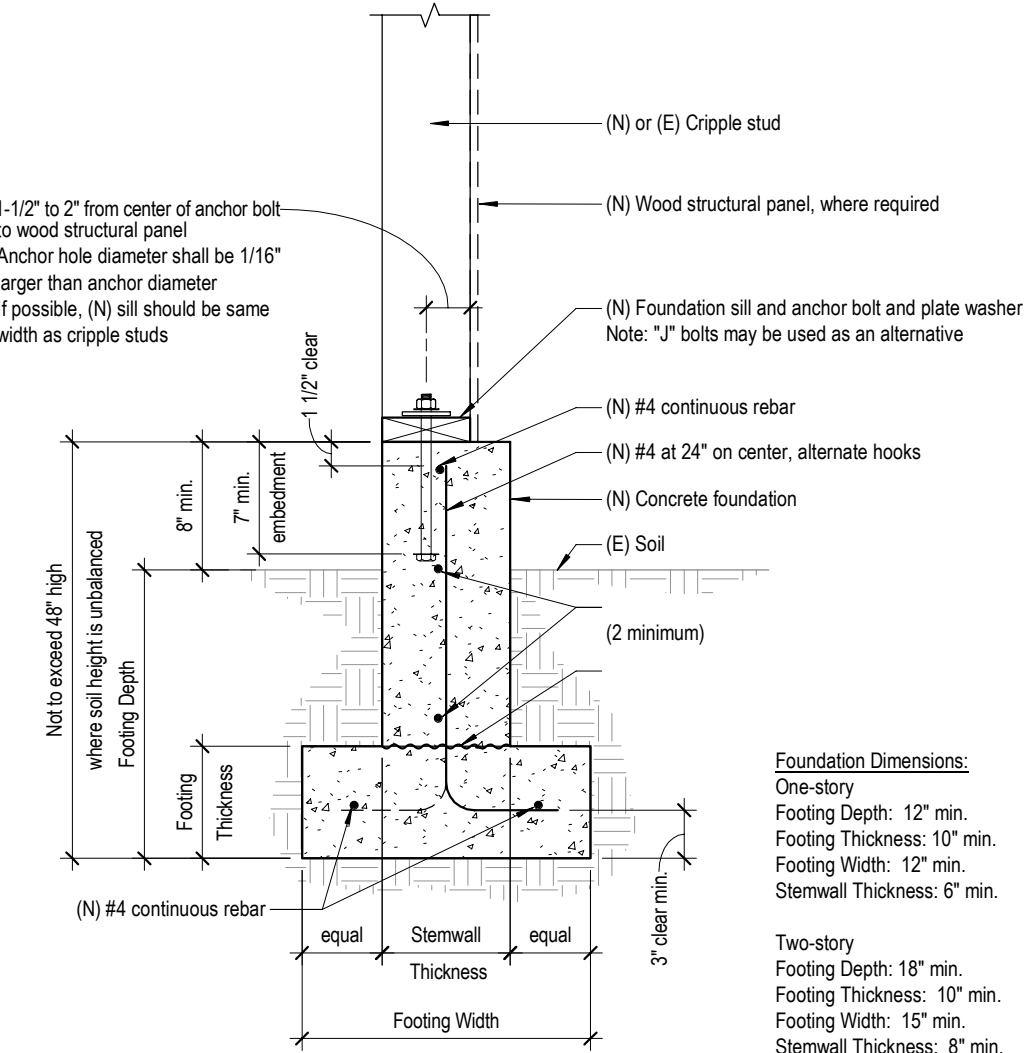
Vent Openings and Top Plate Details

Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date: _____

Sheet: _____

D6

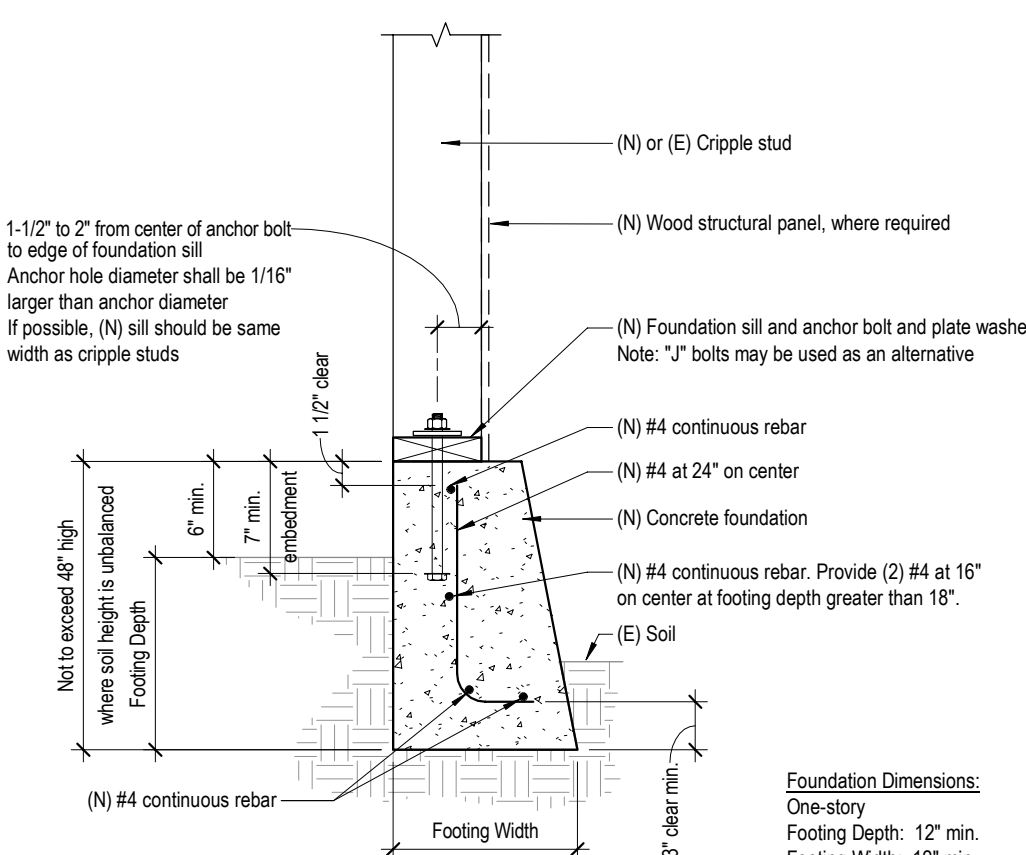


Foundation Dimensions:
 One-story
 Footing Depth: 12" min.
 Footing Thickness: 10" min.
 Footing Width: 12" min.
 Stemwall Thickness: 6" min.

Two-story
 Footing Depth: 18" min.
 Footing Thickness: 10" min.
 Footing Width: 15" min.
 Stemwall Thickness: 8" min.

- Notes:
- 1.
 - 2.
 - 3.
 - 4.
 - 5.
 - 6.
 - 7.

1 CONCRETE FOUNDATION FOR SECTION REPLACEMENT - OPTION 1



Foundation Dimensions:
 One-story
 Footing Depth: 12" min.
 Footing Width: 12" min.

Two-story
 Footing Depth: 18" min.
 Footing Width: 15" min.

- Notes:
1. Contact Building Official to verify applicability.
 2. Where frost conditions occur, the minimum depth shall extend below the frost line.
 3. Footing to be deepened as required to bear on firm soils.
 4. When expansive soil is known to exist, the foundation depth and reinforcement shall be as approved by the Building Official.
 5. Where (N) foundations are placed adjacent to (E) foundations, connect (N) and (E) foundations with (3) #4 x 3'-6" dowels. Embed dowels 8" minimum into the (E) foundation with adhesive. See General Notes, Section M.
 6. A geotechnical report or modified foundation may be required at locations with expansive or liquefiable soils or sites with potential for sliding.

2 CONCRETE FOUNDATION FOR SECTION REPLACEMENT - OPTION 2

MATERIAL KEY:

Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at connectors attached over plywood	0.148" x 3" long
10d (10 penny) at connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long

Structural wood screws	[REDACTED]
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw

Wood structural panel	15/32" Plywood sheathing. Exposure rating of Exterior or Exposure I. 4- or 5-Ply. or Oriented Strand Board (OSB) Conforming to US Voluntary Product Standard PS 2. Exposure rating of Exterior or Exposure I. Manufactured with exterior glue. Minimum 4-ply.
-----------------------	---

LVL (laminated veneer lumber)	[REDACTED]
-------------------------------	------------

Plate washer	3" x 3" square x 0.229" thick.
--------------	--------------------------------

"Peel & Stick" flashing tape bituthene	[REDACTED]
--	------------

ABBREVIATIONS

(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

Foundation Replacement Details

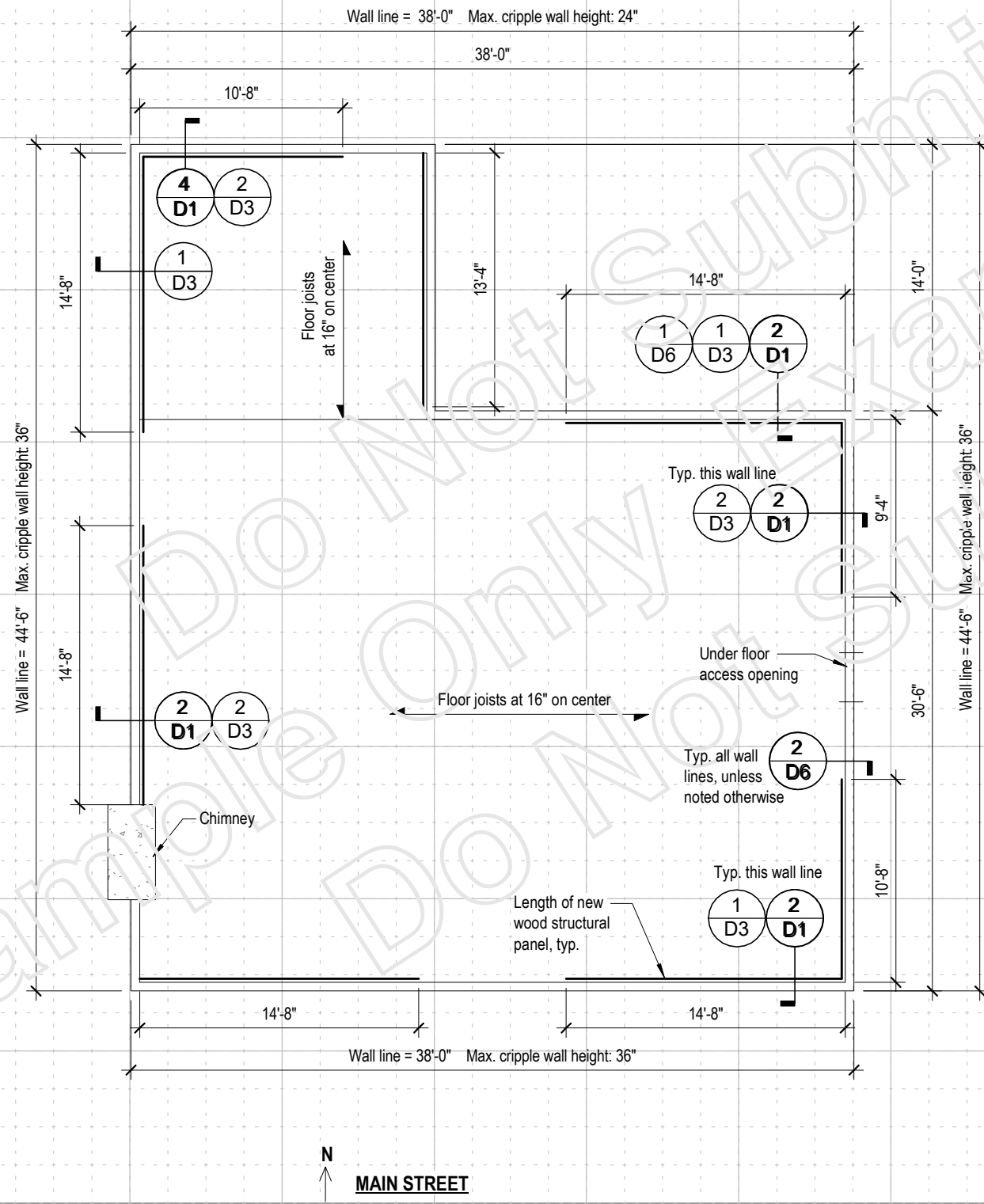
Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Date:

Sheet:

D7

APPLICANT: _____
 PROPERTY ADDRESS: _____



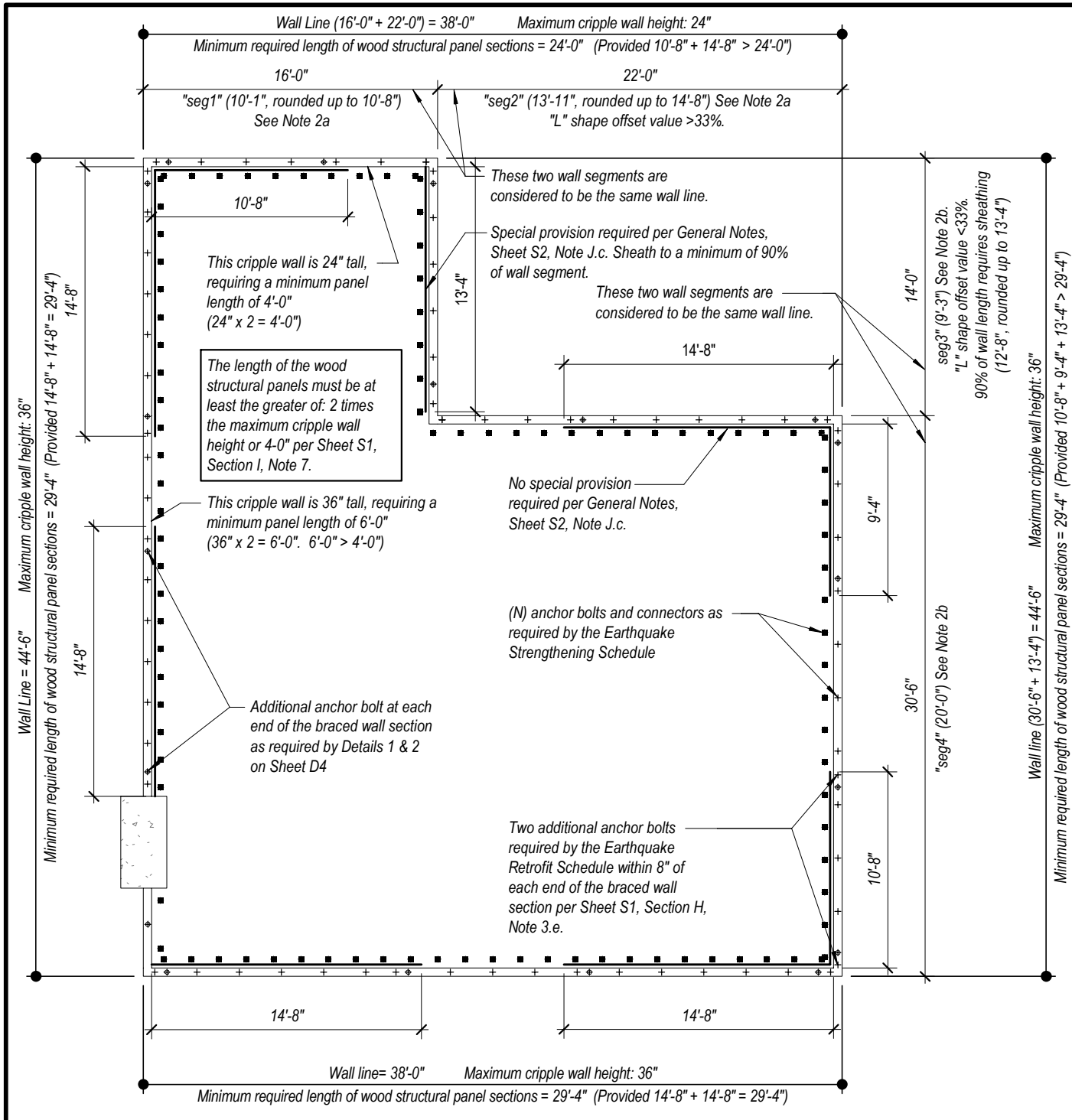
APPLICANT: _____

Example of Foundation and Strengthening Layout Plan

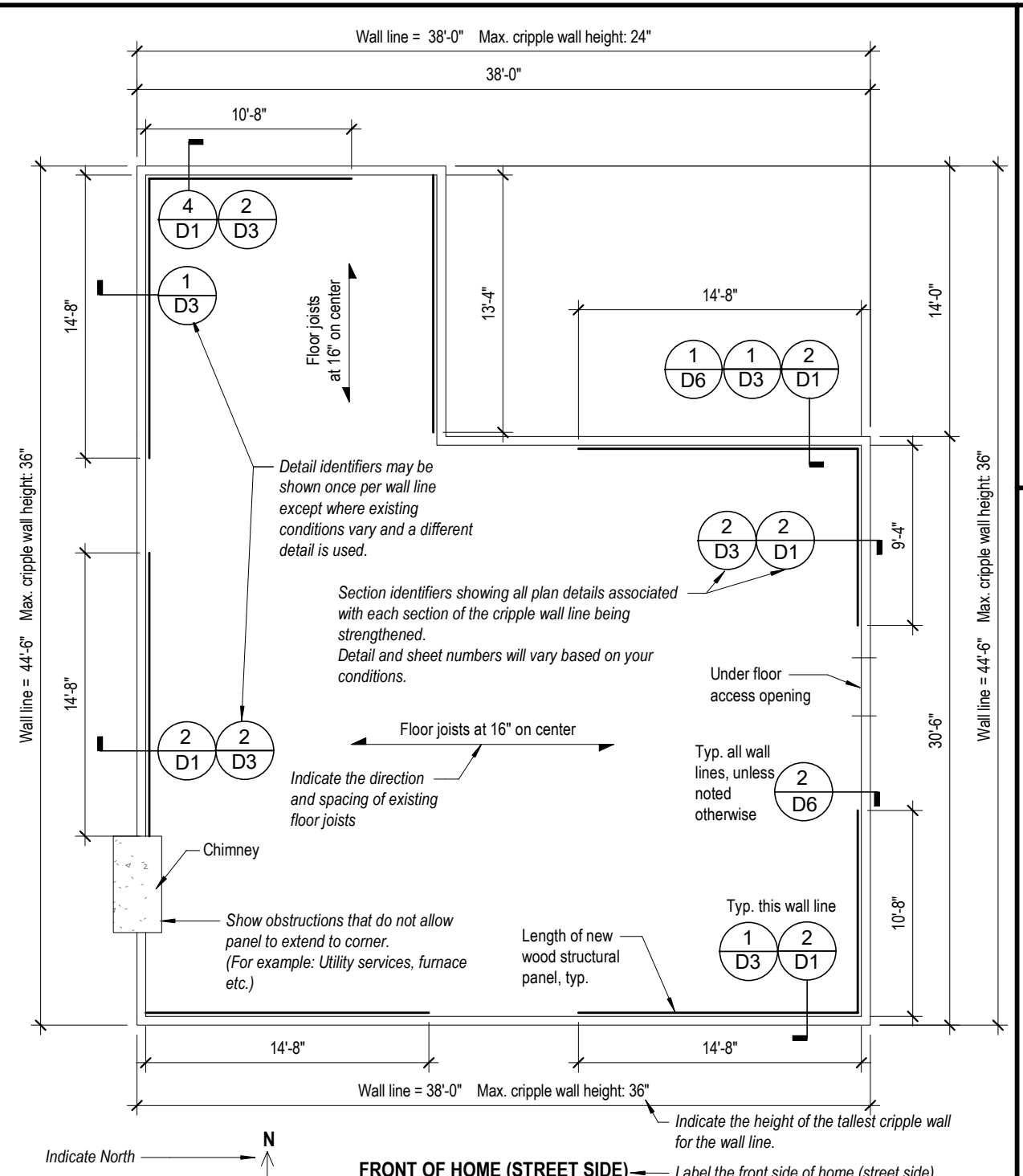
Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of
 One- and Two-Family Dwellings

ONE SQUARE = 2 FEET

X1



EXAMPLE OF CALCULATING TOTAL STRENGTHENING REQUIREMENTS



EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING OFFICIAL

This example is a 1383 square foot, 1-story home with a "Light" weight classification in a very high seismic area. Using the S_{ps} 1.5/One-Story Earthquake Strengthening Schedule from Sheet S3.1, the 1201-1500 Total Area row shows that the length of strengthening required is 29'-4" (14.7x2) at the three 36" high cripple wall lines and 24'-0" (12x2) at the 24" high cripple wall line. The wall lines of this home allow enough length to use wood structural panels without tie-downs. This example uses 1/2" Anchor Bolts (17 required per wall line), and Type "E" Connectors (25 required per wall line).

- Notes:**
- Plans show a typical building foundation. Instructional notes are in *italics* and should not be included on submittal drawing. See Sheet X1 for an example of a final plan. Refer to Sheet 01 for additional instructions.
 - Sample calculations for offset walls as shown above (See Section J of the General Notes on Sheet S1):
 - Approximate length of strengthening required for segments "seg1" and "seg2" at the north wall line:

$$\text{seg1} = 24'-0" \left(\frac{16'}{16'+22'} \right) \approx 10'-1" \quad \text{seg2} = 24'-0" \left(\frac{22'}{16'+22'} \right) \approx 13'-11"$$
 - Length of strengthening required for segments "seg3" and "seg4" at the east wall line:

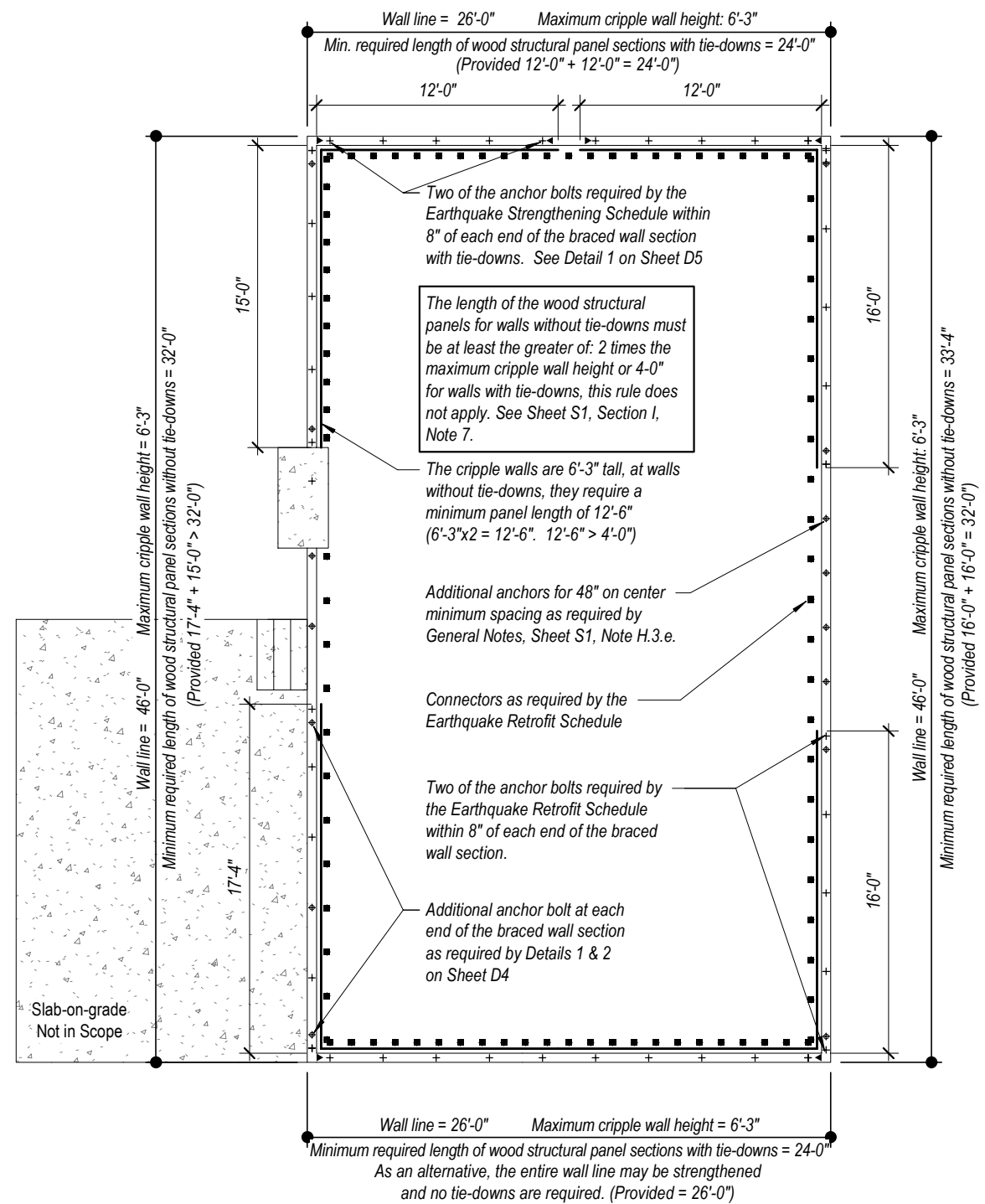
$$\text{seg3} = 29'-4" \left(\frac{14'}{30'-6"+14'} \right) \approx 9'-3" \quad \text{seg4} = 29'-4" \left(\frac{30'-6"}{30'-6"+14'} \right) \approx 20'-1"$$
 - Required length values are rounded up to be at 16" typical stud space increments.

- Key:**
- Minimum required length of strengthening using wood structural panels, anchors, and connectors
 - + Foundation sill anchor or connector
 - ◆ Additional foundation sill anchor or connector
 - Floor connector
 - — Detail Number (Homeowner or Contractor to choose most appropriate detail)
 - — Sheet Number

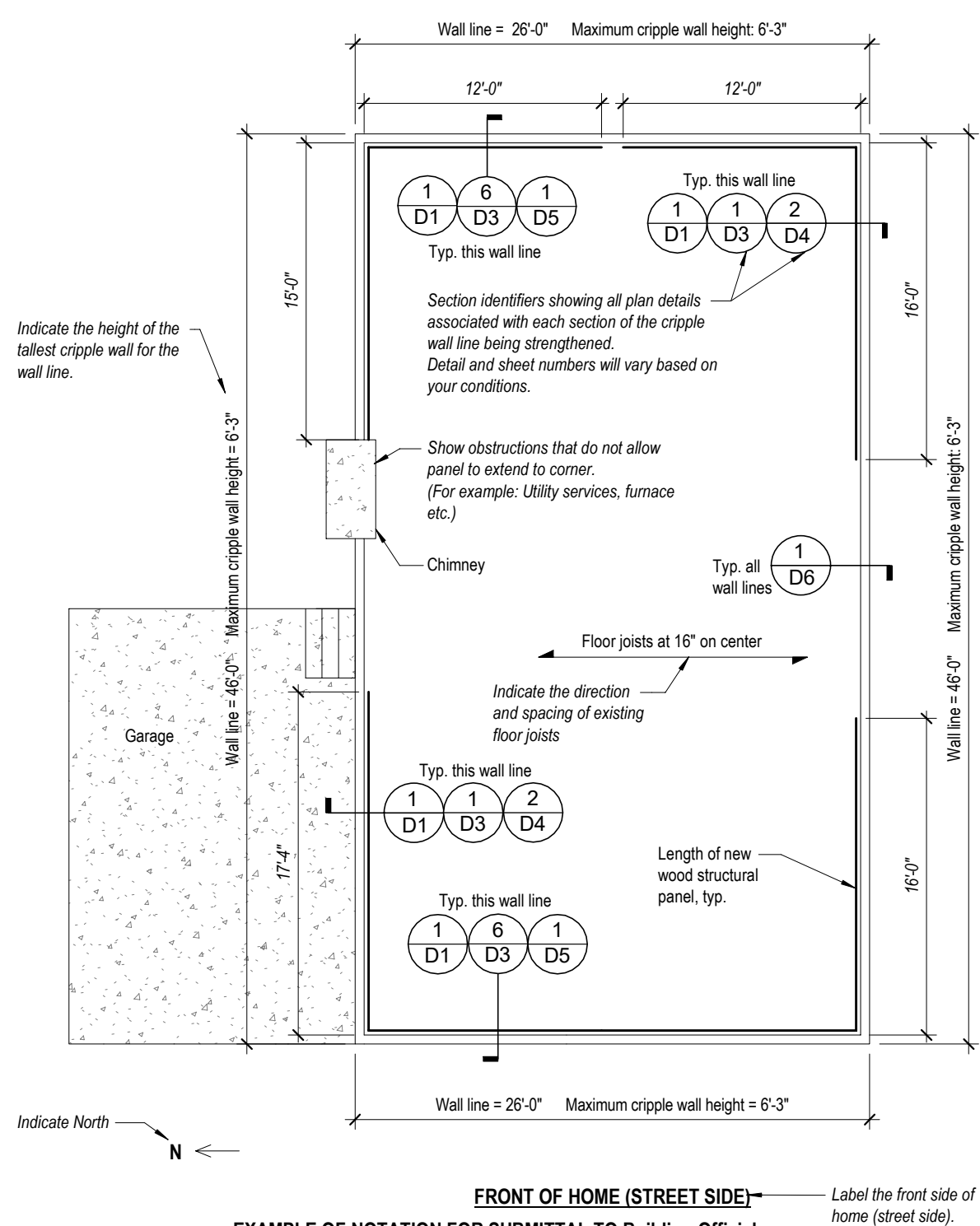
- Definitions:**
- (E) Existing
 - (N) New
 - Strengthening: Foundation and/or cripple wall work intended to improve performance during an earthquake.
 - Wall line: All wall segments forming the overall building dimension on one side.

Example - Foundation Plan (Dwelling without tie-downs)

Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings



EXAMPLE OF CALCULATING TOTAL STRENGTHENING REQUIREMENTS



EXAMPLE OF NOTATION FOR SUBMITTAL TO Building Official

This example is a 2398 square foot two-story home (excluding garage and porch), with a "Light" weight classification in a low seismic area. Using the SDS 1.0/Two-story Earthquake Strengthening Schedule from Sheet S3.1, the 2001-2400 Total Area row shows that the length of strengthening required is 32'-0" (16x2) for the uniform cripple wall height of 6'-3". The side walls allow enough length to use wood structural panels without tie-downs. The front and back walls do not provide enough length and will require tie-downs, this will reduce the required length to 24'-0" (12x2). This example uses 5/8"Ø Anchor Bolts (10 required per wall line) and Type "D" Connectors (23 required per wall line).

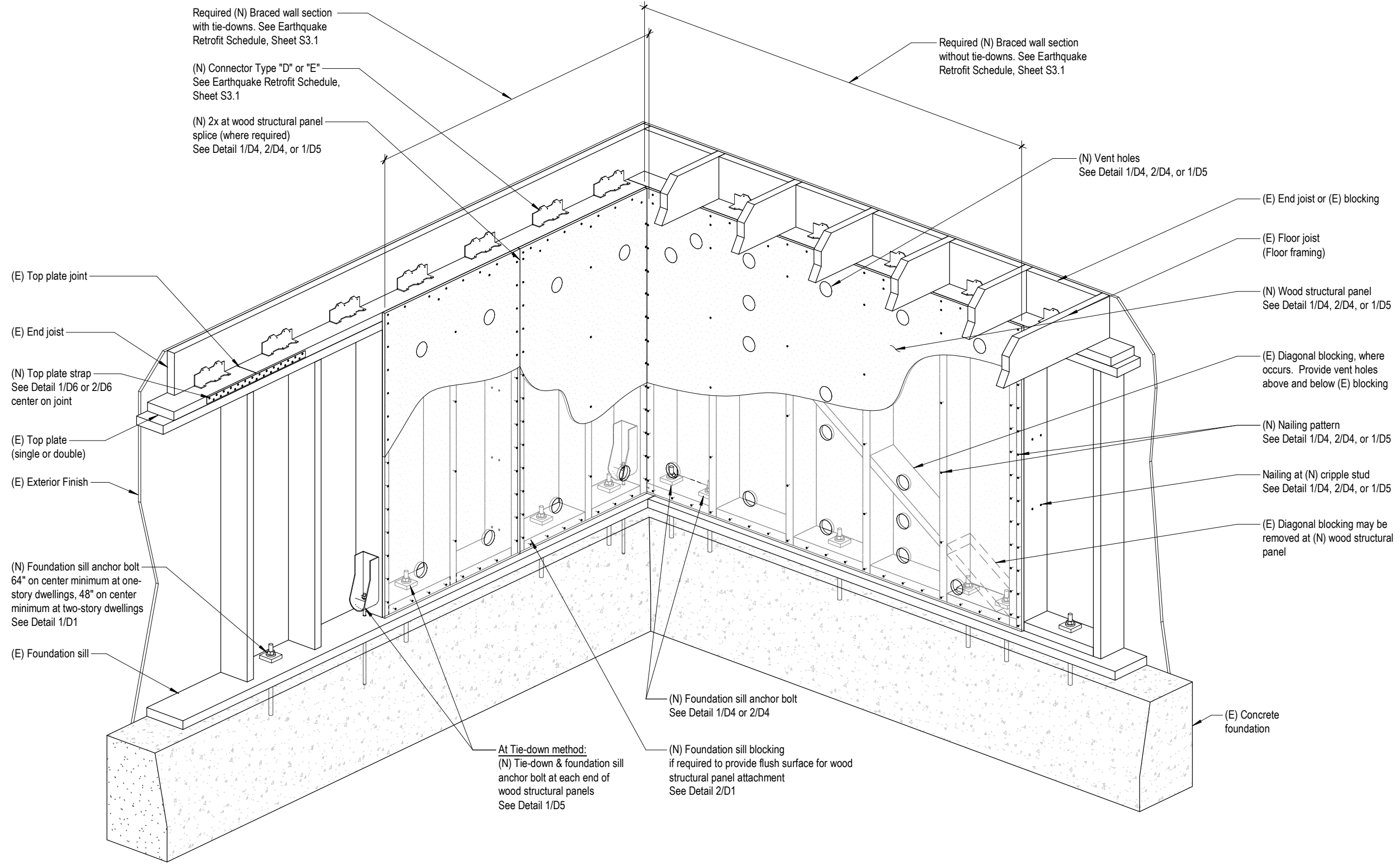
- Notes:**
- Plan shows typical notation. Instructional notes are in *italics* and should not be included on submittal drawing. Refer to Sheet 01 for additional instructions.
 - Required length values are rounded up to be at 16" typical stud space increments.

- Key:**
- Minimum required length of strengthening using wood structural panels, anchors, and connectors
 - + Foundation sill anchor bolt or connector
 - ◆ Additional foundation sill anchor or connector
 - ▶ Tie-down
 - Floor framing connector
 - — Detail Number (Homeowner or Contractor to choose most appropriate detail)
 - — Sheet Number

- Definitions:**
- (E) Existing
 - (N) New
 - Strengthening: Foundation and/or cripple wall work intended to improve performance during an earthquake.
 - Wall line: All wall segments forming the overall building dimension on one side.

Example - Foundation Plan (Dwelling with tie-downs)

Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings



Required (N) Braced wall section with tie-downs. See Earthquake Retrofit Schedule, Sheet S3.1

(N) Connector Type "D" or "E" See Earthquake Retrofit Schedule, Sheet S3.1

(N) 2x at wood structural panel splice (where required) See Detail 1/D4, 2/D4, or 1/D5

Required (N) Braced wall section without tie-downs. See Earthquake Retrofit Schedule, Sheet S3.1

(N) Vent holes See Detail 1/D4, 2/D4, or 1/D5

(E) Top plate joint

(E) End joist

(N) Top plate strap See Detail 1/D6 or 2/D6 center on joint

(E) Top plate (single or double)

(E) Exterior Finish

(N) Foundation sill anchor bolt 64" on center minimum at one-story dwellings, 48" on center minimum at two-story dwellings See Detail 1/D1

(E) Foundation sill

(E) End joist or (E) blocking

(E) Floor joist (Floor framing)

(N) Wood structural panel See Detail 1/D4, 2/D4, or 1/D5

(E) Diagonal blocking, where occurs. Provide vent holes above and below (E) blocking

(N) Nailing pattern See Detail 1/D4, 2/D4, or 1/D5

Nailing at (N) cripple stud See Detail 1/D4, 2/D4, or 1/D5

(E) Diagonal blocking may be removed at (N) wood structural panel

(N) Foundation sill anchor bolt See Detail 1/D4 or 2/D4

(N) Foundation sill blocking if required to provide flush surface for wood structural panel attachment See Detail 2/D1

At Tie-down method: (N) Tie-down & foundation sill anchor bolt at each end of wood structural panels See Detail 1/D5

(E) Concrete foundation

Notes:

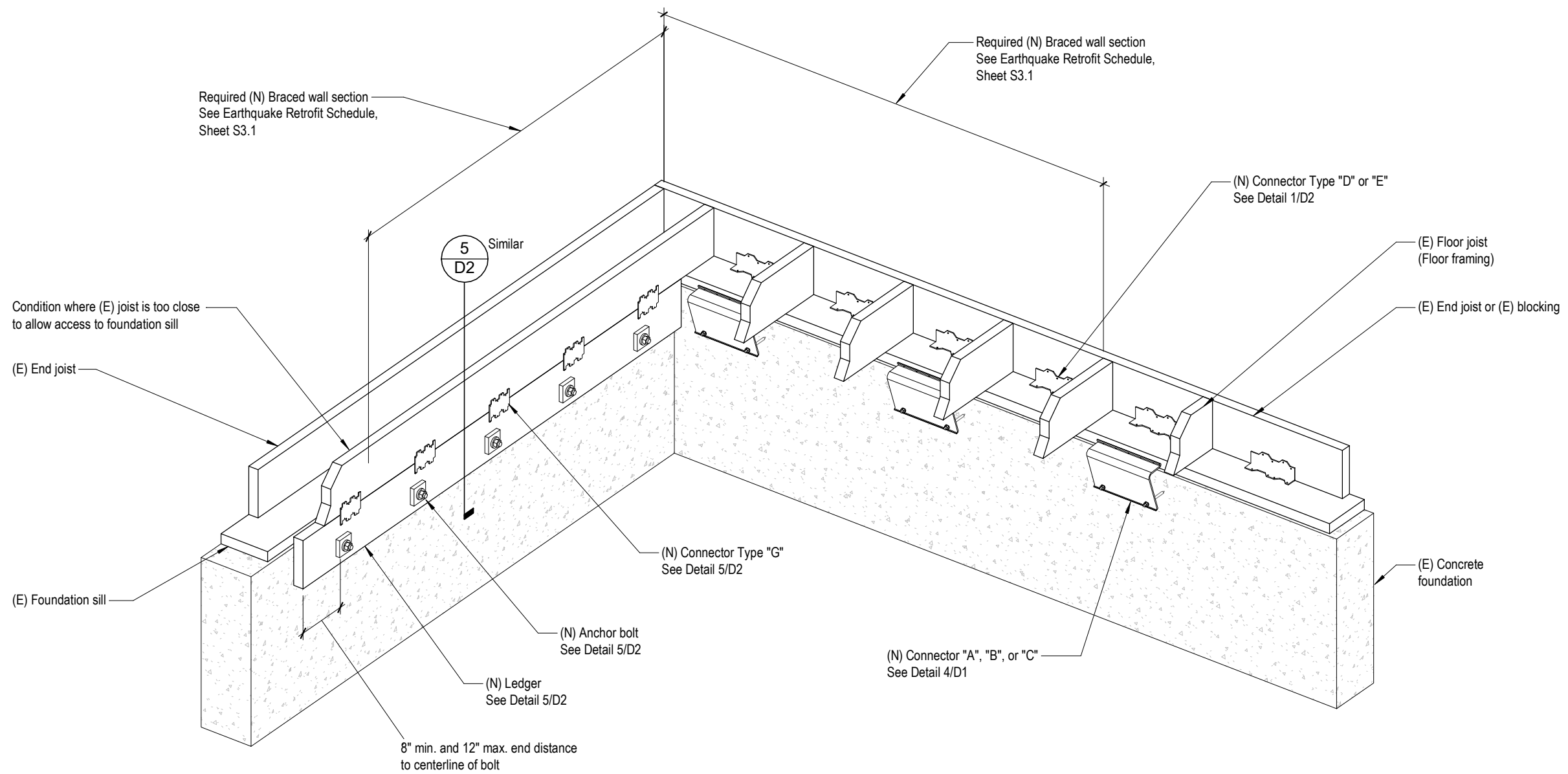
1. This detail is to show an example of cripple wall that has gone through an earthquake retrofit and to identify terms and details used in this plan set.
2. This detail is not intended to supersede requirements contained in the specific installation details on Sheets D1 through D7.
3. This view is looking from the interior of the crawl space.

Definitions

- (E) Existing
- (N) New
- Strengthening: Foundation and/or cripple wall work intended to improve performance during an earthquake.
- Wall line: All wall segments forming the overall building dimension on one side.

Illustration - Cripple Wall Strengthening

Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings



Notes:
 1. This detail is to show an example of an earthquake retrofit where there is no cripple wall, and to identify terms and details used in this plan set.
 2. This detail is not intended to supersede requirements contained in the specific installation details on Sheets D1 through D6.
 3. This view is looking from the interior of the crawl space.

Definitions

(E) Existing
 (N) New
 Strengthening: Foundation and/or cripple wall work intended to improve performance during an earthquake.
 Wall line: All wall segments forming the overall building dimension on one side.

Illustration - Strengthening - No Cripple Wall

Retrofit of Crawlspace Dwellings (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of
 One- and Two-Family Dwellings