Seismic Retrofit Training

For Building Contractors & Inspectors

PARTICIPANT HANDBOOK

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Cover Photo:	Hale House (1887) Heritage Square Museum Los Angeles, California
Photo Credit:	Timothy P. McCormick, P.E.

PARTICIPANT HANDBOOK

ABOUT THIS TRAINING COURSE

The City of Los Angeles, and the Structural Engineers Association of Southern California (SEAOSC) created a task force to study the reason for the widespread damage in the 1994 Northridge Earthquake. The task force concluded that one primary cause of damage was the *lack of quality control* in the design, construction, and inspection of wood frame buildings. The Federal Emergency Management Agency (FEMA), State of California Office of Emergency Services (OES), City of Los Angeles, SEAOSC and the Building Industry Association (BIA) joined forces to provide additional training in seismic-resistant construction. This course is one outcome of their cooperative effort.

This course seeks to teach building contractors and building inspectors the correct methods for doing typical seismic retrofits that have been designed by an engineer or architect or described in a prescriptive standard. The course will not teach one how to design a seismic retrofit, but rather how to properly implement the design.

Woodward Clyde Federal Services and the Hazard Mitigation Technical Assistance Partnership, Inc. created this manual and course update. The new course includes some elements of the original course prepared by Wiss, Janney, Elstner Associates, Inc. and Organizational Learning Systems, Inc. Revisions to the manual and course content are primarily the work of the private instructional team of experts FEMA originally hired to teach the course. The FEMA instructional team members are:

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Editor-in Chief

The authors express sincere appreciation to Jeanne Perkins, Patrick McClellan, Linda Noson and Anthony Qamar for their valuable contributions to the earth science portion of Earthquake Basics.

The authors have presented the information in this manual as a one-day seminar to several thousand building contractors and inspectors throughout the State of California. The seminars were presented under the sponsorships of FEMA, OES, BIA, International Conference of Building Officials (ICBO), the Association of Bay Area Governments (ABAG), Pacific Coast Building Conference (PCBC), and the State of California Department of Insurance.

The California Earthquake Authority sponsored the addition of a new section to this FEMA manual, namely *Retrofitting Post and Pier Houses*. This section creates a new prescriptive standard for floor support systems that are common in the northern coastal regions of California and elsewhere. The Hazard Mitigation Technical Assistance Partnership, Inc. created this section through James E. Russell, Building Code Consultant.

COURSE INFORMATION LIMITS

Any opinions, findings, conclusions or recommendations expressed in this manual do not necessarily reflect the views of the Federal Emergency Management Agency, California Office of Emergency Services, California Earthquake Authority, Building Industry Association, Structural Engineer's Association of California, City of Los Angeles or any other sponsors of the seminar training. The authors of this manual are solely responsible for its content. Additionally, neither the creators, sponsors nor authors of this manual make any warranty, expressed or implied, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, product, or process included in this manual. Users of information from this manual assume all liability arising from such use

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Abbreviation Table for Figure Credits

APA-EWA - The Engineered Wood Association
EERI - Earthquake Engineering Research Institute
FEMA - Federal Emergency Management Agency
ICBO - International Conference of Building Officials
ISANTA - International Staple and Nail Tool Association
SBA - Structural Board Association
SEAOC - Structural Engineers Association of California
ABAG- Assoc. Of Bay Area Governments
WJE - Wiss, Janney, & Elstner Associates
Chylinski - Richard Chylinski, FAIA
Ferrell- Elizabeth Ferrell, AIA
Kiefer - Stephan A. Kiefer, C.B.O.
McCormick - Timothy P. McCormick, P.E.
Mehlmauer- George E. Mehlmauer

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1 INTRODUCTION

by Timothy P. McCormick, P.E.

COURSE OVERVIEW

This course describes retrofit methods for light wood frame buildings that have structural weaknesses for resisting earthquakes. The training focuses on understanding how these retrofit methods work and how to install them. It also shows how to avoid making typical retrofitting errors. This course is not intended to teach you how to design a retrofit, but rather how to implement one. Much of this information is also useful for other types of work, such as the construction of new houses or apartment buildings.

This training will benefit:

- Contractors who wish to learn how to do seismic retrofit work or wish to improve their current seismic retrofitting skills.
- Building Inspectors who are responsible for checking seismic retrofit work.
- Plan Reviewers who approve designs for the seismic retrofit of wood structures.
- Property Owners who want to retrofit their wood frame buildings.
- Realtors who need to understand the earthquake weaknesses of existing dwellings and ways to retrofit them.
- Lenders and Insurers who need to understand the seismic weakness of existing buildings and the retrofit methods that reduce their risks.
- Construction Attorneys who need to understand proper installation and retrofit techniques.

Although this course was developed in California, there are over 30 of the nation's states that are exposed to damage by earthquakes. Many of these states have wood frame structures similar to those in California. As a result, the retrofit techniques discussed in this course have widespread importance.

TRAINING OBJECTIVES

By the end of this training, you should be able to:

- Generally explain how shaking damages wood frame structures during an earthquake.
- Identify the key components of a retrofit (shear walls, holdowns, foundation, anchor bolts, sill plates & other connections).
- Describe how the components connect together to form a proper seismic retrofit.
- Compare and contrast the different material types available for each component of a retrofit.
- Recall the installation steps for each component.
- Recognize the typical errors made during installation and how to avoid making them.
- Understand basic methods for reducing earthquake hazards of chimneys, water heaters, tanks, building appendages, gas lines, brick veneer, and other nonstructural items.
- List basic safety measures to consider when doing retrofit work.
- Recognize areas of potential liability related to construction and ways to avoid or reduce liability.

- Generally explain the building permit requirements, warranties, and liabilities related to seismic retrofit work.

THE REASONS THAT OWNERS RETROFIT

There are many reasons for retrofitting. Owners who occupy the building may retrofit to ensure the safety of their family. Landlords may wish to avoid future loss of income from a vacant and damaged building. Many insurance companies will not write earthquake or homeowner's insurance until needed retrofitting is done. Some cities and counties mandate seismic retrofits when alterations reach a specific dollar amount or enough square footage is added to the building.

Special real estate transfer rules exist in California for residential dwellings. If the structure was built prior to January 1, 1960 and it contains one to four living units of conventional light-frame construction, the transferor must disclose any of the following deficiencies they are aware of:

- The absence of anchor bolts securing the sill plate to the foundation.
- The existence of perimeter cripple walls that are not braced with plywood, blocking, or diagonal metal or wood braces.
- The existence of a first-story wall or walls that are not braced with plywood or diagonal metal or wood braces.
- The existence of a perimeter foundation composed of unreinforced masonry.
- The existence of unreinforced masonry dwelling walls.
- The existence of a habitable room or rooms above a garage.
- The existence of a water heater that is not anchored, strapped, or braced.

The transferor is also required to disclose any material information within the transferor's actual knowledge regarding any corrective measures or improvements taken to address the items listed above. See the California Government Code Section in Appendix B for full details.

MANY BUILDINGS NEED RETROFITTING

California Government Code Section 8897 says, "… there are approximately 1,200,000 homes in the State of California which may not be bolted or anchored to their foundations or do not have adequate cripple wall bracing." These homes were generally built prior to the 1950's and can represent one-half of the existing housing stock. Because there will be many houses that will need retrofitting, contractors who know how to do the work correctly will be in great demand!

Question: *Why are we concerned with housing?*

Answer: Because the Northridge earthquake in January 1995 caused more than 48,000 housing units to become uninhabitable in Los Angeles and Ventura counties. Previously the Loma Prieta earthquake in October 1989 caused more than 16,000 housing units to be uninhabitable throughout the Monterey and San Francisco Bay areas. Approximately one-fourth of the total uninhabitable housing units in the Loma Prieta earthquake was from buildings with one-to-four dwellings.

RETROFIT PRESCRIPTIVE STANDARDS

When you build a new house, you have two ways to design the framing. The first method is to have an engineer or architect create the design. The second is to follow the conventional construction provisions of the Uniform Building Code (UBC). Similarly, there are two ways in which a seismic retrofit can be designed for light wood frame houses. The owner or contractor could hire an architect or an engineer to design the retrofit. There are many houses that have complications that will require an engineer or architect to design the retrofit. Another way to retrofit a house is to use a prescriptive standard.

One or two story wood frame dwellings with no more than four units are usually simple structures (Fig.1.1). Retrofitting them often includes such items as bolts in the sill plate and plywood on the cripple walls. Engineers and building officials have developed guidelines to install these and other items needed for a seismic retrofit. These guidelines are called "prescriptive standards".

Even though prescriptive methods are limited to residential buildings containing one to four units, there are several good reasons to have these standards:

1. There are large numbers of one-to-four unit wood frame buildings that have structural weaknesses.

2. The seismic retrofit for many of these structures are simple to install for contractors and many homeowners.

3. Prescriptive standards permit building owners to seismically retrofit simpler buildings without having to hire an architect or engineer to prepare drawings. Although professional advice is generally desirable and frequently required, prescriptive standards may allow appropriate cost savings. This will make retrofitting more desirable.

Fig. 1.1 - Typical Simple Structure House

PRESCRIPTIVE RETROFIT STANDARDS WORK

The Northridge Earthquake taught us that wood frame homes properly retrofitted according to prescriptive standards suffered little to no earthquake damage and remained intact on their foundation. Past earthquakes, including the Northridge earthquake, also showed us that houses retrofitted incorrectly can be damaged just as much as those that were not even retrofitted.

Incorrect or incomplete retrofits can give the homeowner a false sense of security as to how well the home will resist an earthquake. Keep this in mind as we focus on CORRECT methods of installing retrofits that will be effective in reducing the damage to buildings during the next earthquake.

" Incorrect retrofit installations are as bad as having "NO RETROFIT AT ALL! "

WHEN TO HIRE PROFESSIONAL HELP

Since seismic retrofit technology is an evolving process, the participant needs to understand and follow the most current seismic retrofit standards. The authors developed this course using the best available information on the subject at the time. However, this information cannot substitute for professional advice. The services of an architect, civil, structural or geotechnical engineer is frequently required. You will learn more about this throughout the course.

Because the use of prescriptive standards for retrofit work is generally limited to one-to-four unit wood frame residential buildings, commercial and larger residential buildings require the expertise of an engineer or architect to design the seismic retrofit. This is also true for buildings constructed on steeply sloping lots. (Fig. 1.2)

Fig.1.2 - Hillside Homes Require an Architect or Engineer to Design the Retrofit

2 EARTHQUAKE BASICS

by Richard Chylinski, FAIA
Timothy P. McCormick. P.E. and
Stephan A. Kiefer. C.B.O.

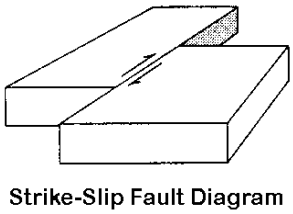
EARTHQUAKE BASICS

This section will give you a basic understanding of the nature of earthquakes and how earthquake forces affect buildings. The more you understand how buildings respond to earthquake forces, the better you will understand what parts of the building resist these forces and how to properly install these structural components.

EARTHQUAKES AND FAULTS

Earthquakes are perceptible movements of the earth's surface. The primary cause of earthquakes is the rupture of faults in the earth's crust and the associated rapid slip on these faults. Large and damaging earthquakes are caused by rupture of faults that are tens to hundreds of miles long. If the fault rupture extends to the surface, we see movement on a fault (surface rupture). But strong earthquakes can occur when the fault rupture does not extend to the surface as seen in both the 1989 Loma Prieta and the 1994 Northridge earthquakes in California.

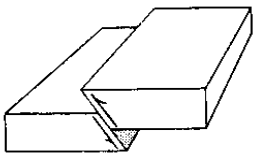
Fault rupture of the ground generates vibrations, or waves, in the rock that we feel as ground shaking. Because faults are weaknesses in the rock, earthquakes tend to occur over and over on these same faults. Most of the major faults in the United States, particularly in California, are strike-slip faults. For these types of faults, the rupture extends almost vertically into the ground and the ground on one side moves past the ground on the other side of the fault. (Fig. 2.1) California's largest fault, the San Andreas, is a strike-slip fault formed where two large chunks of the earth's crust, or plates, move past each other.



Strike-Slip Fault Diagram

Fig. 2.1

Another type of fault is the thrust fault where ground on one side of the fault moves up and over adjacent ground (Fig. 2.2). These faults are much more common in the Los Angeles area than in the Bay Area because the San Andreas Fault makes a large bend to the west there before heading northwest. This bending causes thrust faults in southern California.



Thrust Fault Diagram

Fig. 2.2

Farther north, these same two crustal plates are pushing against each other, with the Pacific Plate diving under the North American Plate along large plate-boundary thrust or "subduction zone" faults (Fig. 2.3). Thus, Oregon, Washington and Alaska are all subject to huge earthquakes caused by this movement, in addition to the more common strike-slip earthquakes. The 1964 Good Friday Alaska earthquake was an example of one of th

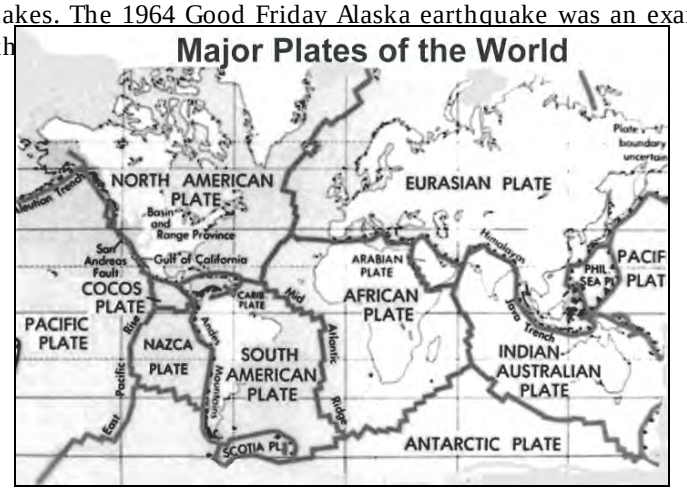
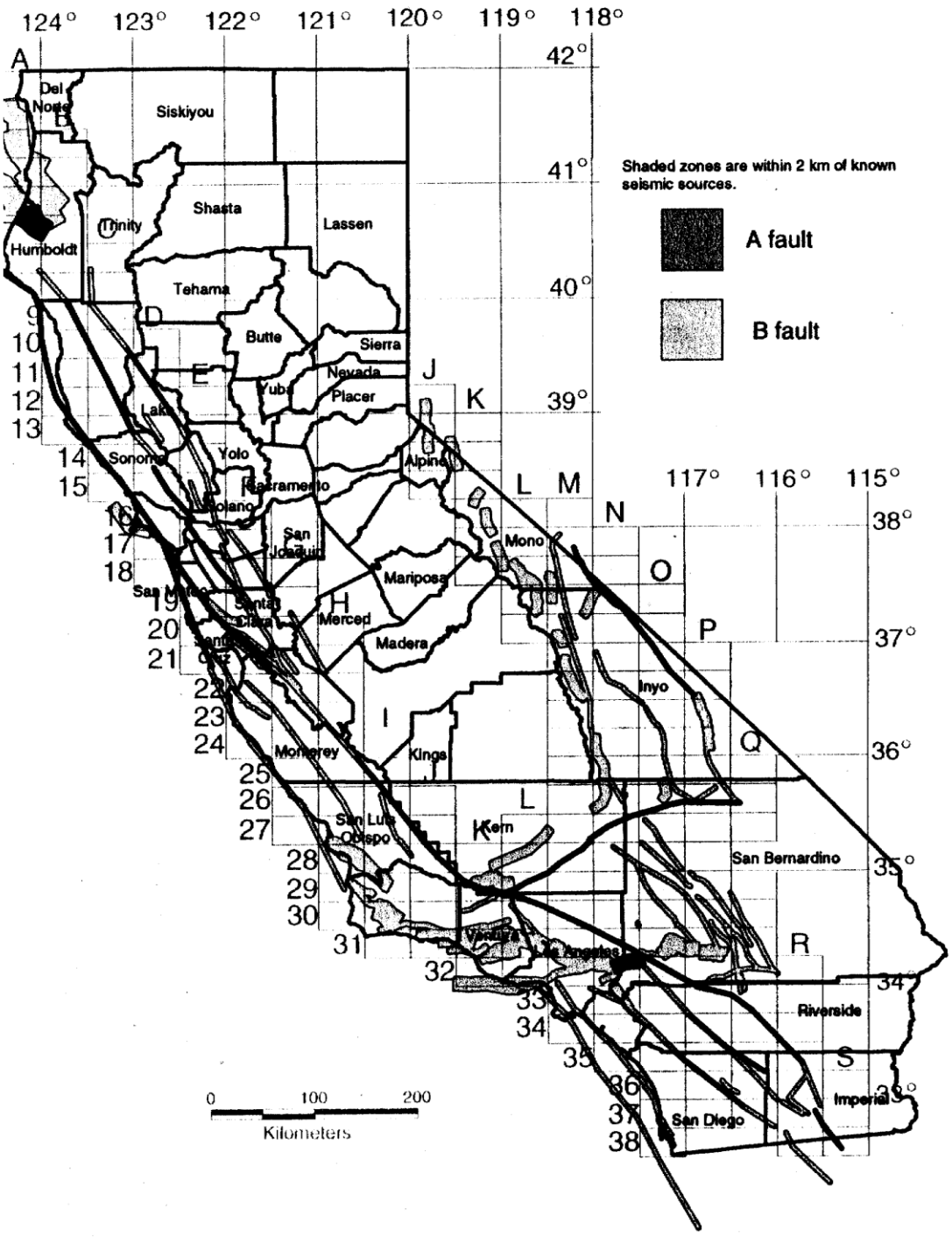


Fig. 2. 3

State of California
Index Map



PROXIMITY TO FAULTS

The magnitude of an earthquake is frequently given as a number on the Richter scale. This scale measures the amplitude of ground motion. Local ground motion from the earthquake will depend on the distance from the fault source to the building and the surface geology under the building.

Earth scientists use certain terms to define seismic distances. The point at which the slippage occurs is called the focus, or hypocenter. The distance from this hypocenter to the surface of the earth is termed the focal depth. The point directly above the hypocenter is called the epicenter ("epi" being Greek for "above"). The locations of earthquakes are frequently given by their epicenter (Fig. 2.5).

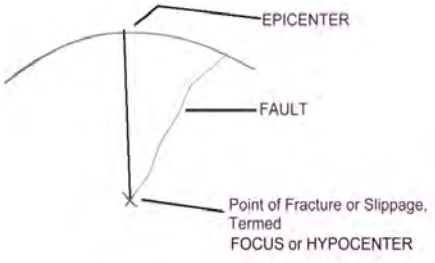


Fig.2.5 Location of Focus and Epicenter

Earthquakes release energy along the entire portion of the ruptured fault surface. Because of this, the distance between the building and the fault source is more important that the distance to the actual epicenter. The Index Map on the left shows the active fault zones in California. The 1997 Uniform Building Code uses this information to determine when earthquake forces on buildings must be increased due to fault proximity (Fig. 2.4). Calculated earthquake forces can increase up to 100 per cent for buildings near large faults.

SURFACE GEOLOGY EFFECTS

Surface geology can amplify the earthquake ground motion. The same districts in San Francisco that were strongly damaged in the great San Francisco earthquake of 1906 were also damaged in the 1989 Loma Prieta earthquake. These damage-prone districts are built on bay mud sites that can amplify ground shaking by a factor of 6 when compared to sites on rock. Sandy soils can amplify shaking by a factor of 2 (Fig.2.6).

Fig. 2.7 Liquefaction Failure

Behind the garage shown in Fig. 2.7 is a stream that saturated the soil with water. The building moved and settled because the earthquake shaking "floated' the soil grains in the water and the soil was able to flow. This type of ground failure is called *liquefaction*. When special soil problems like liquefaction or landslides may occur, a geotechnical engineer should be

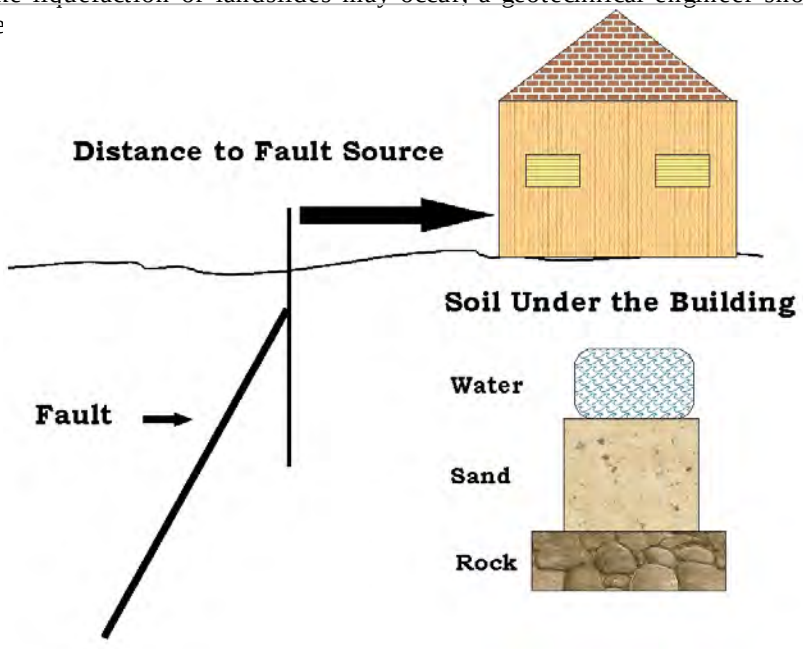


Fig. 2.6 Factors Affecting Earthquake Forces

INERTIA FORCES

Inertia is the tendency for an object at rest to remain at rest, or of an object in motion to remain in motion. Force is the energy required to move or accelerate the object. Inertia forces move or accelerate an object and they are proportional to the object's weight. Seismic forces on buildings are inertia forces.

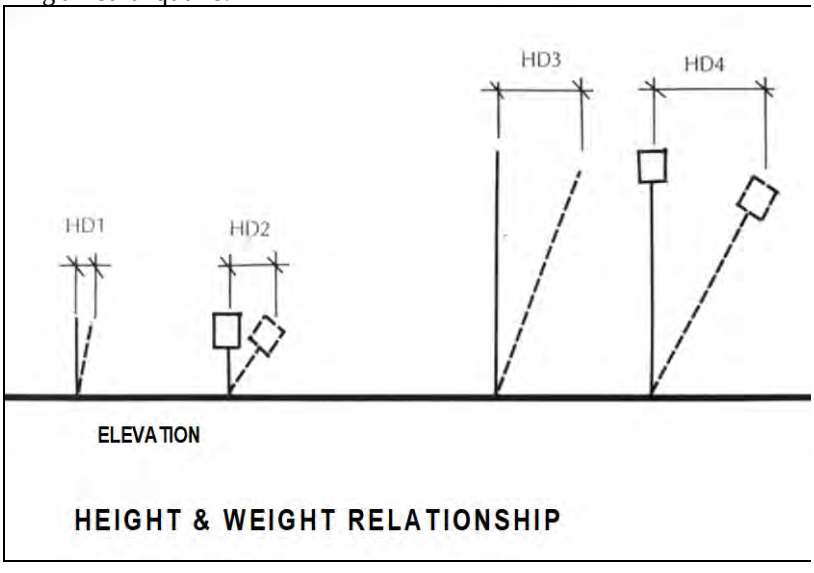
Consider a person standing in the bed of a pickup truck. If the pickup truck accelerated rapidly, inertia would tend to keep that person's body in its original location. Similarly, if the pickup truck decelerated, the person would be thrown forward. (Fig. 2.8) The same reaction occurs in a building when the ground moves. The building moves back and forth, with the bottom of the building moving with the quake and the top tending to remain in place. Now imagine two persons in the back of a pickup truck: one weighing 100 pounds and the other 200 pounds. As the truck accelerates, the individual that weighs 200 pounds would be pushed back with twice as much inertial force as the person who weighs 100 pounds.

For another example, let's assume that there are two tract homes. They are side by side on the same street and identical except that one has an asphalt shingle roof and the other has a heavy clay tile roof. Because clay tiles weighs more than asphalt shingles, the home with the clay tile roof will experience higher inertia forces from the earthquake and, most likely, suffer more damage.

EFFECT OF HEIGHT ON BUILDING MOVEMENT

The effects of earthquake forces on buildings are related to both the weight and height of the building. The higher the building's weight is above its support base, the further the top of the building will move under the same earthquake force. Using the left side of Figure 2-9, imagine a one-story building with a height of 14 feet. Let's say the inertia force of the earthquake moved the top of the building 1 inch (HD1). If you put additional weight on that building, the top of the building will move more. Let's say it moved 1-½ inches (HD2).

Using the right side of Figure 2-9, imagine the same type of building that is two stories or 24 feet high. The top of the building may now move 2 inches. The top of the heavier building may move 3 inches. The greater the height, and/or the greater the weight of a building, the more the building will move during an earthquake.



PERIOD OF VIBRATION

Earthquakes send out shock waves that travel in all directions up to the surface of the earth. These waves impart horizontal and vertical forces to earth-supported structures. Because buildings are designed to continuously support vertical loads from their own weight and use, they tend to better resist these vertical forces and move up and down safely with the ground. However, horizontal force waves cause buildings to move laterally and vibrate back and forth during an earthquake. Unless the building is properly constructed, these horizontal forces will cause damage.

The time an object takes to vibrate back and forth one complete cycle is known as its period of vibration. The period of vibration is one of the most important factors determining how a structure will respond to ground shaking. For one or two-story wood frame buildings, the period of vibration is about ½ a second. This means that these buildings will go through their complete cycle of seismic motion about two times per second. For an earthquake with strong ground shaking that lasts 15 seconds, the building will go through this cycle approximately 30 times (Fig. 2-10).

Because periods of vibration depend on weight and height, portions of building with different weights and heights will move separately unless all portions of the building are properly connected and tied together. Common examples of different portions of buildings with these problems

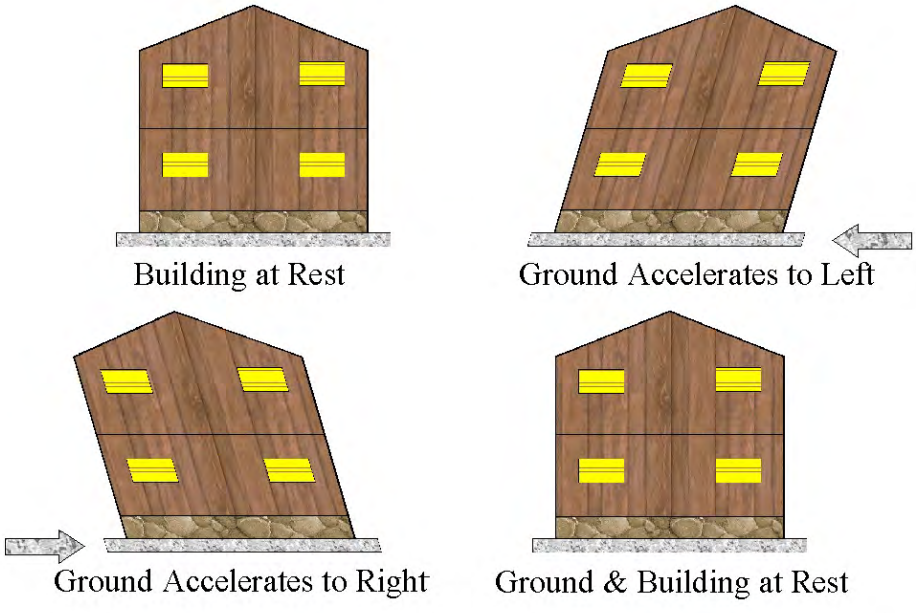


Fig. 2. 10 Cyclic Motion of Building

Fig. 2. 1
Failure

Fig. 2.12

Fig. 2.13

HORIZONTAL FORCE DISTRIBUTION

Newton's Second Law of Motion states that force equals mass times acceleration. When the earthquake's sudden movement of the ground accelerates the mass of the building, horizontal forces are created in the building. These forces are distributed throughout the building and are concentrated where the weight is: the floors, roofs and walls.

Consider the two-story building in Figure 2.14. The arrow at the roof represents the seismic force from both the roof weight and one-half of the weight of the walls between the second floor and roofline. The arrow at the second floor represents the seismic force of both the second floor weight and one-half of the weight of the first and second story walls. The arrow at the first floor represents the force at the first floor that is similarly calculated. The arrow at the foundation level is the sum of all these forces that must be transmitted safely into the ground.

BASE SHEAR AND CRIPPLE WALLS

A cripple wall is a wall that is less than full story height. The cripple wall usually occurs between the first floor and the foundation and is generally the most vulnerable part of older buildings (Fig.2.15). These cripple walls are weak because they are typically sheathed with only stucco or horizontal wood siding on the exterior side of the wall. These sheathing materials are weak wall-bracing methods for seismic loads. You will learn more about this in the section on "Shear Walls".

Because seismic forces in the building accumulate all the way down to the ground, they are greatest at the base of the building. The seismic force at base of the building is called the *base shear* Earthquakes often damage buildings at this level (Fig. 2.16). For buildings with cripple walls, this means that the weakest part of the building must resist the greatest force. This is why retrofit standards require strengthening of the cripple walls.

HORIZONTAL FORCE-RESISTING SYSTEM

The horizontal force-resisting system is composed of both horizontal and vertical parts. The horizontal parts are the roof and the floor structures. These parts are called *diaphragms* The vertical elements are the walls that span between the horizontal elements. These walls are called *shear walls*. You will learn more about these in the section on *Shear Walls.*

To be effective, each part of the horizontal force-resisting system must be adequate and properly connected to the other parts in the system. For example, the roof diaphragm must be strong enough to safely resist the seismic loads. Also, the connections from the roof diaphragm to the shear walls below must be strong enough to give the force to the shear wall. Shear walls at the base of the building must be securely connected to the footing and the footing must be adequate. To have an effective horizontal force-resisting system, there must be a continuous load path. That is, there must be no weak elements between the top and bottom of the structure.

SEISMIC LOAD PATH IN THE BUILDING

The load path can be thought of as a chain. It is only as strong as its weakest link. The roof and floor diaphragms and shear walls are two links in the chain. The connections between the roof, walls, floors and foundation are additional links. These additional links serve as the connective points that complete the chain. The connections are just as important as the diaphragms and shear walls themselves. The seismic loads imparted on a building must successfully pass through all of these elements in order to reach the ground and effectively resist an earthquake's damaging forces. In other words, the load path or chain must be continuous and complete. There can be no weak links in the load path

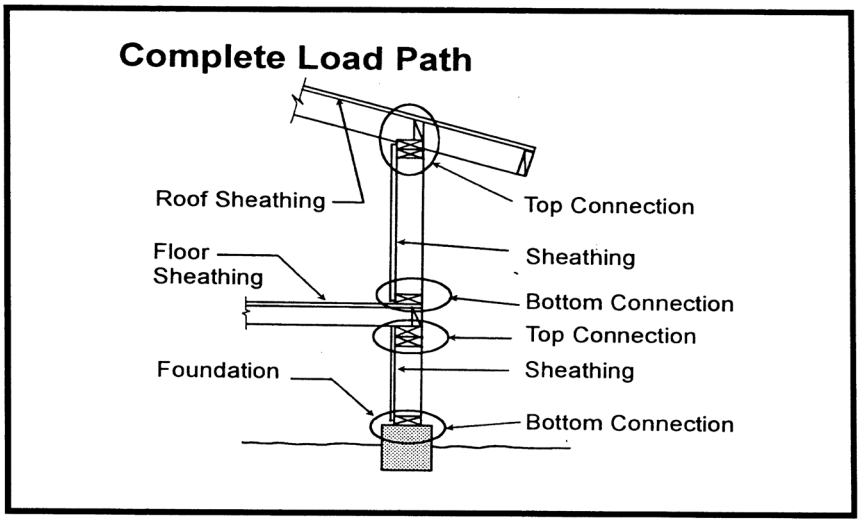


Fig. 2.17

When a part of the load path is weak or missing, damage will occur during an earthquake. If the sill plate is not connected to the foundation wall, the ground will move and leave the building behind (Fig. 2.18). A building without shear walls like the one in Figure 2.19 can collapse. When there is not enough room for an adequate shear wall (e.g. a wall with many large windows), an engineer or architect must design a special frame to resist the horizontal forces, These frames are called *moment frames*.

GRAVITY FORCE RESISTING SYSTEM

Some of the elements of a gravity or vertical force-resisting system can and will be used to resist the horizontal loads. In the gravity force-resisting system there are live and dead loads transferred from the wood roof rafters to the walls; the live and dead load from the floor loads are transferred to the cripple walls, and then to the foundations where they are resisted by the soil below them.

Alterations to the lateral system should not compromise the ability of the gravity force-resisting system to support these loads. The purpose of the horizontal force-resisting system is to enable the gravity force-resisting system to maintain its support of the structure during earthquakes and windstorms.

***

3 SHEAR WALLS

by Timothy P. McCormick, P.E.

SHEAR WALLS

This section provides an introduction to shear walls and how they resist earthquake and wind forces. This section also shows how to properly construct the shear walls and the parts that make them up. With this knowledge, contractors can build proper shear walls and inspectors can recognize the errors untrained contractors make.

GETTING THE BIG PICTURE

WHAT IS A SHEAR WALL?

Shear walls are vertical elements of the horizontal force resisting system. They are typically wood frame stud walls covered with a structural sheathing material like plywood. When the sheathing is properly fastened to the stud wall framing, the shear wall can resist forces directed along the length of the wall. When shear walls are designed and constructed properly, they will have the strength and stiffness to resist the horizontal forces. (Fig. 3.1)

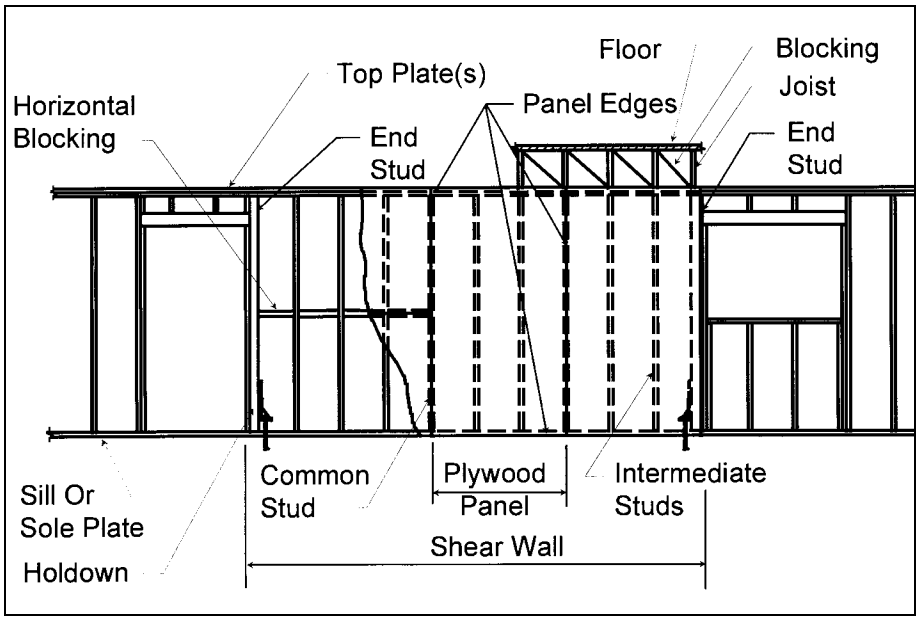


Fig.3.1 - Typical Shear Wall

WHERE SHOULD SHEAR WALLS BE LOCATED?

Shear walls should be located on each level of the structure including the crawl space. To form an effective box structure, equal length shear walls should be placed symmetrically on all four exterior walls of the building. Shear walls should be added to the building interior when the exterior walls cannot provide sufficient strength and stiffness or when the allowable span-width ratio for the floor or roof diaphragm is exceeded. For subfloors with conventional diagonal sheathing, the span-width ratio is 3:1. This means that a 25-foot wide building with this subfloor will not require interior shear walls until its length exceeds 75 feet unless the strength or stiffness of the exterior shear walls are inadequate. (Fig. 3.2)

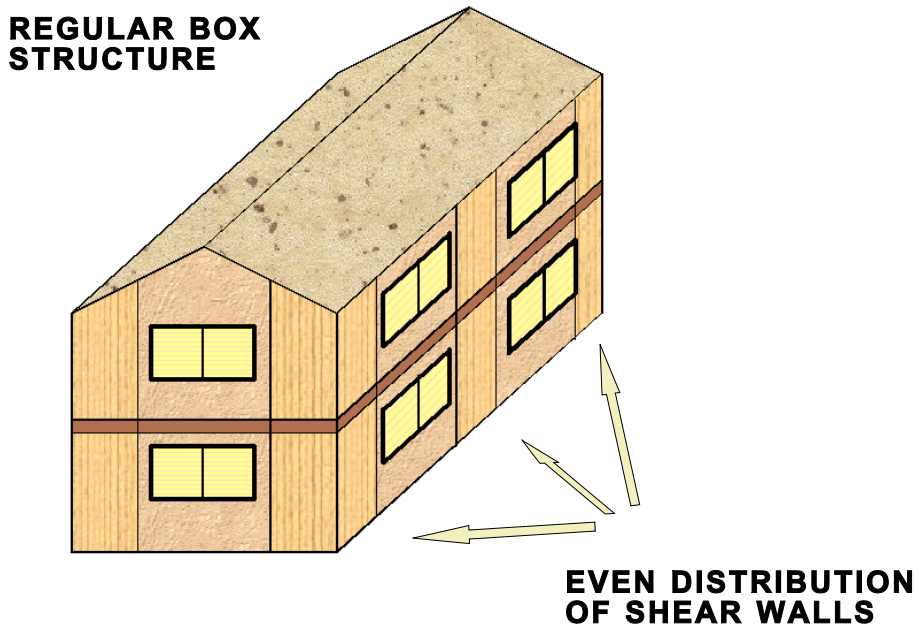


Fig.3.2 - Location of Shear Walls

Shear walls are most efficient when they align vertically and are supported on foundation walls or footings. When shear walls do not align, other parts of the building will need additional strengthening. Consider the common case of an interior wall supported by a subfloor over a crawl space and there is no continuous footing beneath the wall. For this wall to be used as shear wall, the subfloor and its connections will have to be strengthened near the wall. For new construction, thicker plywood or extra nailing and connections can be added. For retrofit work, existing floor construction is not easily changed. That's the reason why most retrofit work uses walls with continuous footings underneath them as shear walls. (Fig. 3-3)

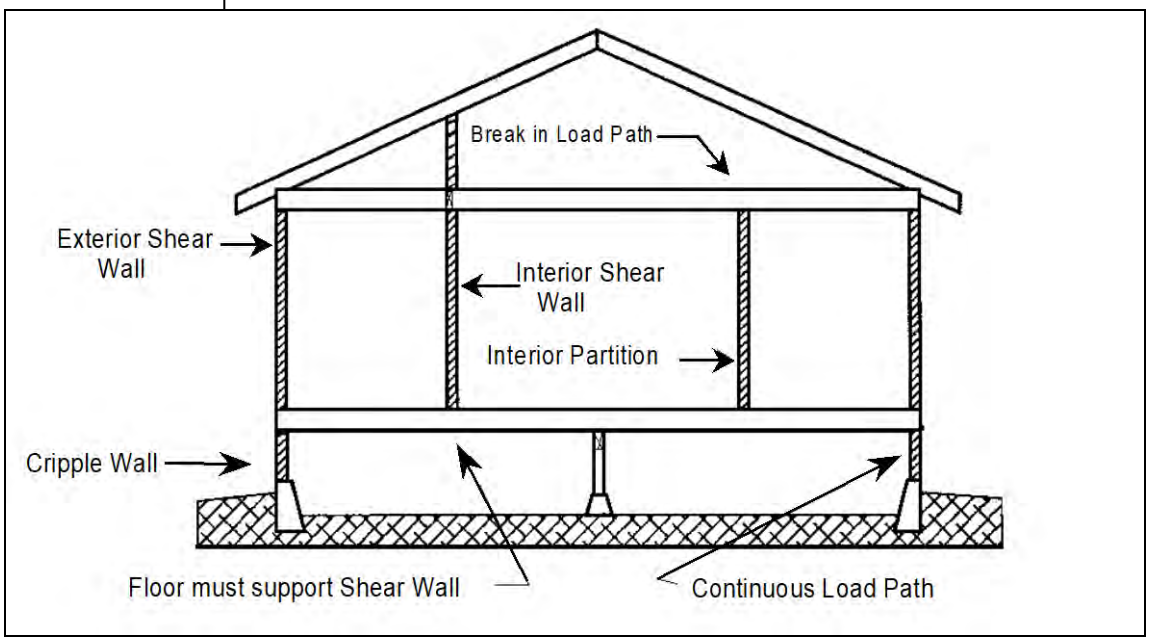


Fig. 3-3 Horizontal Alignment of Cripple Walls

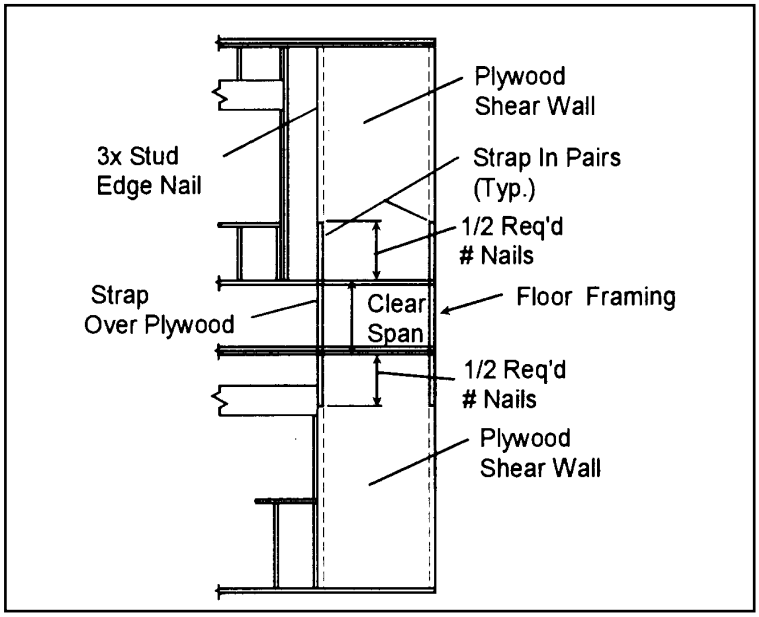


Fig. 3.4 -Vertical Offset of Shear Walls

Another type of alignment problem occurs when the ends of shear walls do not align from story to story. This condition creates the need for extra framing members and connections in the walls for holdown devices. Holdown devices must transfer the uplift from the shear wall to framing members that can resist it. When full height studs are not available, special connections must be added. These connections must assemble enough of the structure's framing to resist the uplift. (Fig. 3-4, 3.5)

Fig.3.5 - Shear Wall Over Floor Beam

WHAT TYPES OF FORCES DO SHEAR WALLS RESIST?

Shear walls resist two types of forces: shear forces and uplift forces. Connections to the structure above transfer horizontal forces to the shear wall. This transfer creates shear forces throughout the height of the wall between the top and bottom shear wall connections. The strength of the lumber, sheathing and fasteners must resist these shear forces or the wall will tear or "shear" apart (Fig. 3-6).

Fig. 3.6 – Shear Force on 3-Ply Plywood

Fig. 3.7 - Uplift Forces on Shear Wall

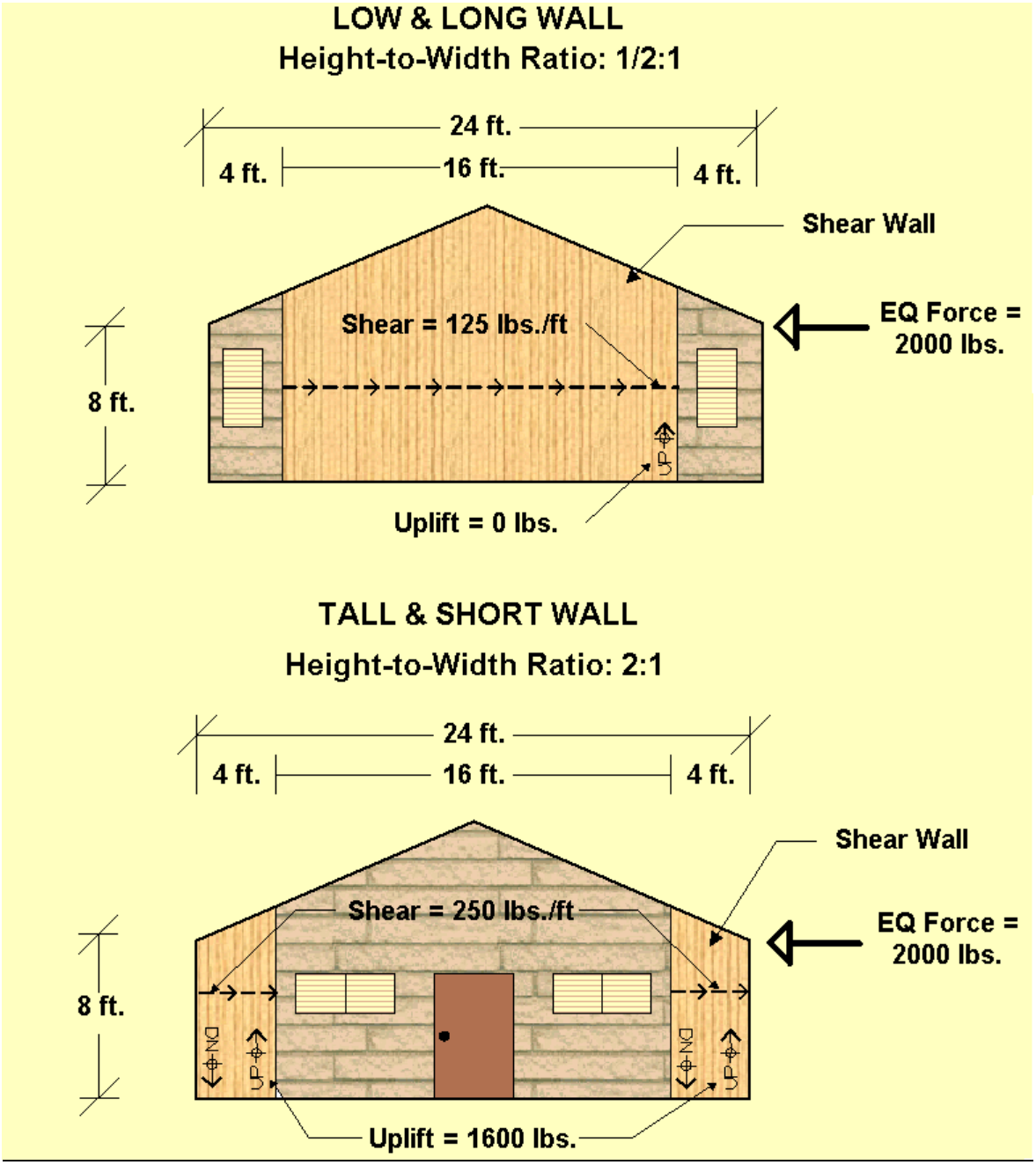


Fig 3.8 - How Shear Wall Length Changes Shear & Uplift

Uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Uplift forces are greater on tall short walls and less on low long walls. Bearing walls have less uplift than non-bearing walls because gravity loads on shear walls help them resist uplift. Shear walls need holdown devices at each end when the gravity loads can not resist all of the uplift. The holdown device then provides the necessary uplift resistance.

WHAT ARE THE FUNCTIONS OF A SHEAR WALL?

Shear walls must provide the necessary lateral *strength* to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them. These other components in the load path may be other shear walls, floors, foundation walls, slabs or footings.

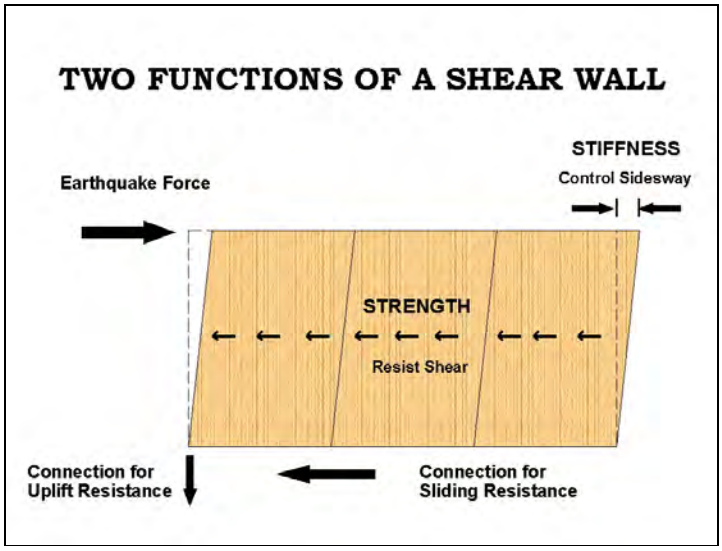


Fig. 3.9

Shear walls also provide lateral *stiffness* to prevent the roof or floor above from excessive side-sway. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage. (Fig. 3.9)

HOW SHEAR WALLS PROVIDE STRENGTH

The strength of the shear wall depends on the combined strengths of its three components: lumber, sheathing and fasteners. Later in this section you will learn how each component effects the strength and how strength is lost by improper installations. When all of the components are properly in place, the shear wall can provide its intended strength.

For shear wall sheathing, the 1994 Uniform Building Code (UBC) permits the use of gypsum wallboard, cement plaster, fiberboard, wood particleboard, plywood and oriented strand board. Previous editions of the UBC also allowed wood lath and plaster, horizontal and diagonal sheathing for shear walls. All of these sheathing materials provide different strengths. The UBC shows these strengths in pounds per foot of wall length.

Fasteners for shear wall construction may be staples, screws or nails. Denser lumber species provide stronger fastener strengths. Values for shear wall strengths assume a dense lumber species like douglas fir-larch or southern pine. Thicker framing members also increase wood structural panel sheathing strengths.

Fig. 3.10 -Lumber Strength Failure

Fig. 3.11 -Sheathing Strength Failure

Fig. 3.12 – Fastener Strength Failure

COMBINING DIFFERENT MATERIAL STRENGTHS

Older editions of the building code allowed the combination of strengths for different materials on the same shear wall. If a wall was sheathed inside with gypsum wallboard and outside with portland cement plaster, the allowable shear strength became the combined strength of the two materials. Before this code provision was deleted in the 1976 Uniform Building Code, several buildings were built under this errant concept and are at a fraction of the strength that the original design intended. Buildings designed with gypsum wallboard or portland cement plaster in combination with structural wood panels will have the same problem. Different sheathing materials do not combine strengths. This is true on the same wall. It is also true for different walls of the same level of the building.

Material strengths cannot combine because different sheathing materials reach their ultimate strength at different wall displacements. Shear walls braced with cement plaster and gypsum wallboard reach their ultimate strength at about one-half inch of movement of the top of the wall. After this point, gypsum wallboard buckles off the studs, frequently leaving its fasteners in place. Portland cement plaster has similar behavior. Structural wood panels reach their ultimate strength when the top of the wall moves about 1½ inches. This means that plywood will share seismic loads with portland cement plaster or gypsum wallboard when the top of the wall moves less than one-half inch. When earthquake forces cause more than ½-inch displacements, the wood structural panel sheathing will have to resist the entire load. Some earthquakes will cause top of wall displacements greater than ½-inch. When they do, the sheathing material that stays on the walls the longest will have to resist the total seismic load. Normally, this sheathing material will be wood structural panel. (Fig. 3.13 & 3.14)

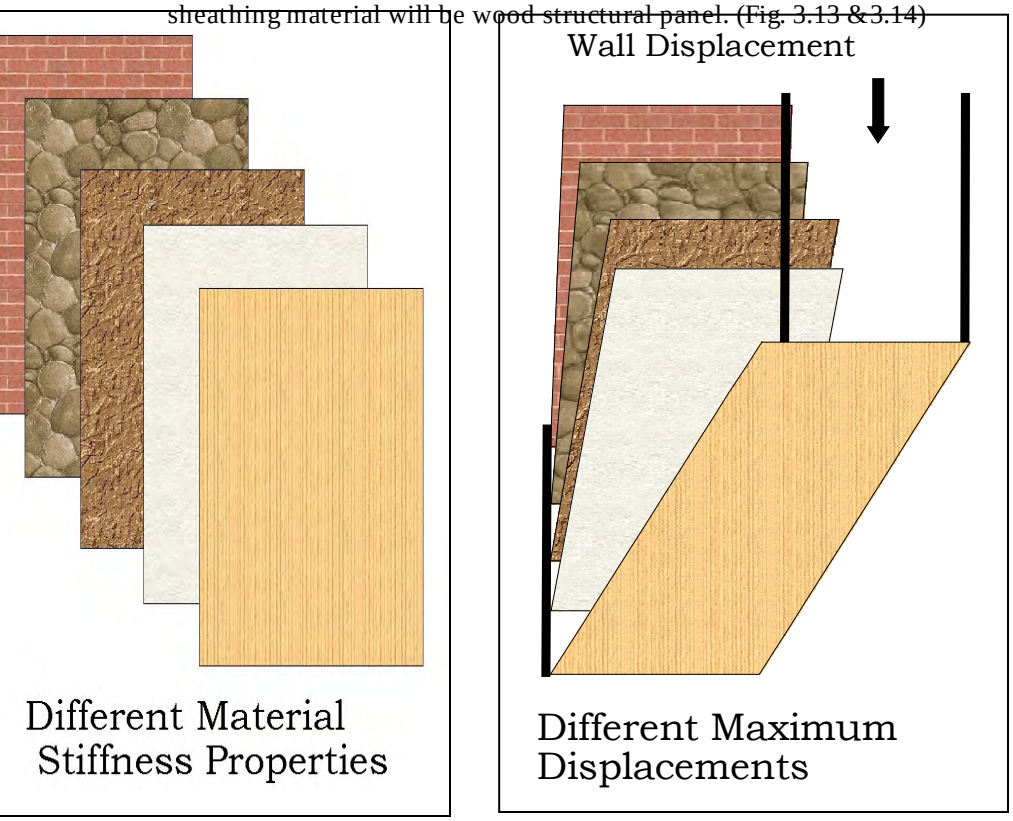


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Fig. 3.14

SHEAR WALLS ARE LIKE WOOD I-BEAMS

Wood structural panel shear walls behave like cantilevered wood I-beams. Just as wood I-beams use their flanges to resist bending, wood structural panel shear walls use their end studs. Both wood I-beams and wood structural panel shear walls use their sheathing web to resist shear forces. Because of their size, wood structural panel shear walls must fasten their sheathing to intermediate wall studs to prevent it from buckling. The stiffness of shear walls constructed with wood structural panels depends on four things:

1. The size and species grade of the end studs
2. The thickness and grade of the sheathing
3. The diameter of the sheathing fasteners
4. The amount of [illegible]

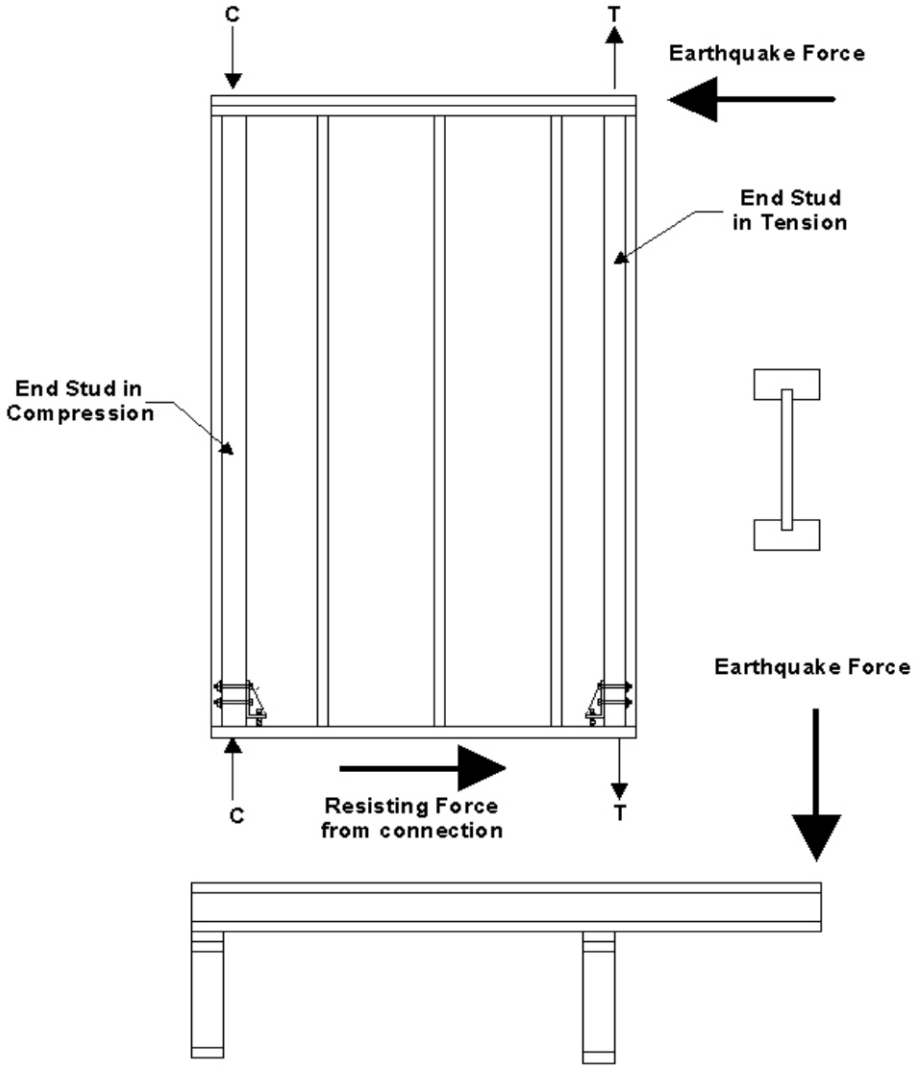


Figure 3-15 – Comparison of Wood Shear Wall to Wood I-Beam

HOW SHEAR WALLS PROVIDE STIFFNESS

The stiffness of the shear wall, just like its strength, depends on the combined stiffness of its three components: lumber, sheathing and fasteners. The size and grade of end stud(s), thickness and grade of sheathing, and the sheathing fastener diameter determine how flexible a wood shear wall will be. When present, holdown devices also contribute to the overall stiffness of the shear wall. If holdown devices stretch or slip, the top of the shear wall will move horizontally. This horizontal movement adds to the movement allowed by the lumber, sheathing and fasteners. Any additional movement from the holdown will reduce the effective stiffness of the shear wall.

STIFFNESS AND ASPECT RATIOS

Shear walls provide stiffness in large part by the ratio of their height to width. Long short walls are stiffer than tall narrow ones. For a wall of constant height, the stiffness will grow exponentially as the wall length increases. To help control stiffness, the UBC requires a minimum wall length for any given wall height. This allowable dimension ratio changes for each type of sheathing material and its construction. Wood structural panels can have smaller shear wall lengths than cement plaster or gypsum wallboard. When this sheathing is fastened at all of its edges, the UBC also permits smaller shear wall lengths.

94 Uniform Building Code - Wood Frame Shear Values

Material	Allowable Shear, lbs/ft	Maximum Height-To-Width Ratio	Minimum Width for 8 Foot High Wall
ath &plaster	100	1½:1	5 feet-4 inches
vallboard-unblocked	100-145	1½:1	5 feet-4 inches
vallboard-blocked	125-250	2:1	4 feet -0 inches
d	125-175	1½:1	5 feet-4 inches
cement plaster-unblocked	180	1½:1	5 feet-4 inches
cement plaster-blocked	180	2:1	4 feet-0 inches
sheathing-conventional	300	2:1	4 feet-0 inches
sheathing-special	600	3½:1	2 feet-4 inches
uctural panels &particleboard	140-870	3½:1	2 feet-4 inches

Table 1 – Allowable Aspect Ratios

vable shear values for gypsum lath and wallboard must be reduced 50% in Seismic Zones 3
.
1997 Uniform Building Code reduces the maximum allowable height-to-width ratios to 1:1 onventional diagonal sheathing and 2:1 for special diagonal sheathing, wood structural ls and particleboard in Seismic Zones 3 and 4.

LESSONS FROM THE NORTHRIDGE EARTHQUAKE

After each major earthquake, scientists and engineers study the performance of structures so that building codes may be evaluated and improved as needed. After the 1994 Northridge Earthquake, the City of Los Angeles and Structural Engineers of Southern California formed a joint task force to re-evaluate several seismic provisions of the building code for wood frame buildings. The task force recommended significant changes to the design and construction of wood frame shear walls. These changes included lowering the allowable height-to-width ratios and shear strength values.

The following table shows the former (UBC) and new (LABC) code provisions that the City of Los Angeles and many Southern California communities adopted following the Northridge Earthquake.

1994 Uniform Building Code
City of Los Angeles Building Code Amendments (LABC)
Wood Frame Shear Wall Construction

Shear Wall Sheathing Material	Allowable Shear, lbs./ft		Maximum Height-To-Width Ratio	
	UBC	LABC	UBC	LABC
gypsum lath & plaster	100	30	1½:1	1:1
gypsum wallboard-unblocked	100-145	30	1½:1	1:1
gypsum wallboard-blocked	125-250	30	2:1	1:1
fiberboard	125-175	0	1½:1	-
portland cement plaster-unblocked	180	90	1½:1	1:1
portland cement plaster-blocked	180	90	2:1	1:1
plywood -3 ply panels	200-770	150-200	3½:1	2:1
plywood & OSB- 3/8 inch	200-730	150-200	3½:1	2:1
particleboard	140-870	175	3½:1	2:1
diagonal sheathing-conventional	300	300	2:1	2:1
diagonal sheathing-special	600	600	3½:1	2:1
wood structural panels	200-870	150-650	3½:1	2:1

Table 2- Reduced Code Values

Fig. 3.16 - Drywall Failure

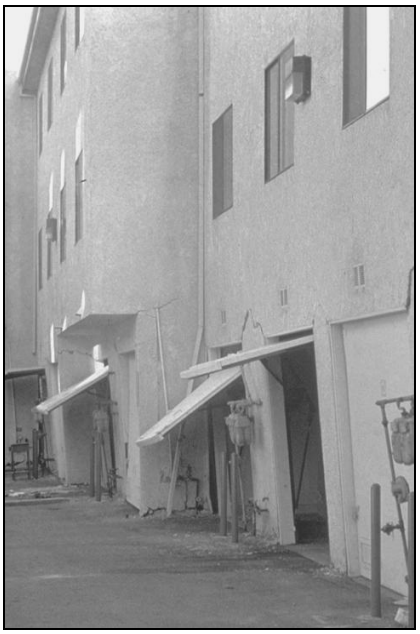


Fig. 3-18-Narrow Panel Failure

SUCCESS OF PLYWOOD SHEATHING

The most important lesson that the Northridge Earthquake taught us about wood frame shear walls was the good performance of plywood sheathing. Shear walls sheathed with plywood performed significantly better than other sheathing materials such as gypsum wall board or portland cement plaster. The apartment building shown below in Figure 3.19 had minimal damage from the Northridge Earthquake because of its extensive use of shear walls sheathed with plywood.

The best plywood sheathing is Structural 1 grade with a minimum of four-ply panel construction. Three-ply plywood panel construction tore at its inner ply seam. For this reason, prescriptive standards often specify five-ply plywood for shear wall sheathing.

Fig. 3.17 -Stucco Failure

Fig. 3. 19 – Success of Full Plywood Coverage

WOOD STRUCTURAL PANEL SHEAR WALLS

This part of the Shear Walls section will discuss the components of wood structural shear walls, their correct installation and the effects on seismic performance when they are improperly installed. The components examined will be lumber, sheathing, and fasteners. Holdown devices and shear transfer connections will be discussed in the next section, "*Connections*."

How to Install the Lumber

USE THE PROPER LUMBER SPECIES

The lumber of choice in California for new construction is usually douglas fir-larch. Some hem-fir is used for pressure treated sill plates. Older buildings used foundation grade redwood for sill plates and some used redwood for all framing members. Shear walls constructed with hem-for or redwood are weaker than shear walls constructed with douglas fir-larch.

Density of the lumber species determines how well the sheathing fasteners will hold. Shear walls constructed with lower density lumber do not hold fasteners as well as shear wall constructed with denser lumber. The Uniform Building Code requires an 18% strength reduction for walls built with the less-dense hem-fir and a 35% reduction for open grain redwood. The following table shows some of the different allowable shears based on the species of the lumber framing.

Wood Structural Panel		Common Nail Size	Nail Spacing at Panel Edges	Allowable Shears, lbs./ft. Based on Lumber Species		
Panel Grade	Thickness			Douglas fir-larch	Hem-Fir	Redwood Open Grain
Structural 1	15/32 inch	8d	4	430	355	280
Structural 1	15/32 inch	8d	3	550	450	360
Structural 1	15/32 inch	10d	3	665	545	430

Table 3- Effect of Lumber Species on Strength

There are two types of redwood species for strength considerations: open grain and close grain. Because lumber in a covered structure is not always visible or accessible, verification of the grain pattern in existing buildings may be difficult or unreliable. For this reason, structural designers commonly use the 35% reduction for the less dense open grain. When verification of the denser close grain is possible, shear wall strength values may use a 18% reduction like hem fir. Older buildings are more likely to have close grain from old growth trees.

DETERMINE EXISTING LUMBER SPECIES

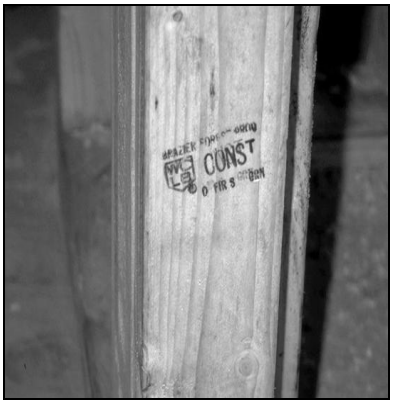


Fig. 3. 20 Stronger Douglas Fir-

Structural designers normally assume that existing lumber is douglas fir-larch. When retrofit work uncovers existing redwood or hem fir lumber, contractors and inspectors should notify the structural designer so that additional shear wall strength can be provided. Otherwise, hem fir framing will provide only 82 percent and the redwood will provide only 65 percent of the shear wall strength intended. (Figs. 3.20 & 3.21)

Prescriptive standards for retrofit work generally do not consider the effect of different lumber species. Although not required in such standards, additional sheathing fasteners are recommended for the softer lumber species. The use of 10d commons at 3 inches on center in redwood or 8d common at 3 inches on center in hem-fir is equivalent to the a prescriptive standard of 8d commons at 4 inches on center in douglas fir-larch framing. See the shaded portions in Table 3- Effect of Lumber Species on Strength.

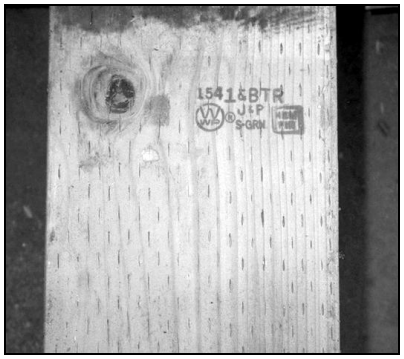


Fig. 3. 21 Weaker Hem Fir

When termite or fungus damage requires the repair or replacement or existing framing members, contractors should use douglas fir-larch lumber to replace all studs, blocking, sill and top plates. Douglas fir-larch should be used for both pressure treated and non-pressure treated lumber. *Denser lumber always means better fastener strength and as a result, stronger shear walls.*

USE THE PROPER SIZE STUD

Fig 3.22 Earthquake damage with 2 inch adjoining stud

The 1994 Uniform Building Code requires 3-inch nominal width (2½ net) framing at adjoining panel edges when 6d, 8d and 10d short nails are spaced 2 inches on center or 10d long nails are spaced 3 inches or less on center. Original diaphragm testing by the American Plywood Association (APA) showed that framing members split at ultimate loads when sheathing nails are closely spaced. APA Tests also showed that shear walls are 17% stronger when 3-inch framing is used throughout.

The minimum edge distance for common nails is 5/8 for 6d, ¾ for 8d and 7/8 for 10d. This edge distance should be provided in all framing members and blocking. If an engineer were to use this UBC criteria to design the connection of two adjoining pieces of sheathing to a framing member, nail edge distance requirements in the framing member and sheathing would always require a minimum 3-inch nominal width framing member. Although thicker framing members are not always required by the minimum standards of the building code, using 3-inch nominal width framing at ALL adjoining panel edges will generally increase shear wall strength.

Sometimes it is difficult to install 3-inch nominal width framing in existing construction. An acceptable alternative to 3-inch nominal width framing is to bolt a new stud to the existing stud at the adjoining panel edge. The number of bolts required depends on the shear wall strength and lumber species. For the prescriptive standard, connecting the two studs with ½ inch bolts at 12 inches on center or 5/8 bolts at 16 inches on center will properly join the studs.

INSTALL PROPER SIZE BLOCKING

All of California and portions of Washington, Oregon, Nevada, Utah, Idaho, Montana, and Wyoming are in Seismic Zones 3 or 4. For shear walls in these seismic zones, all edges of wood structural panels must be fastened to framing members or blocking. Blocking must be provided when adjoining panel edges are unsupported between framing members. This situation occurs when the wall heights exceed available panel lengths, panels are installed horizontally, around wall openings or at existing cripple walls. When sheathing panel edges are not fastened, the shear wall is only one-third as strong when all edges are fastened. (Figs 3.23 &3.24)

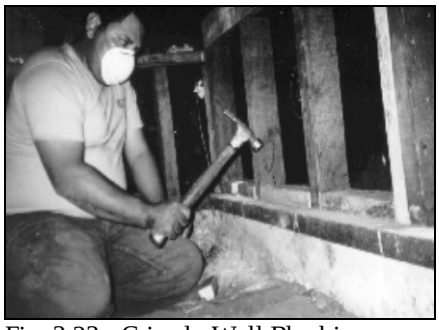


Fig. 3.23 - Cripple Wall Blocking

Just like vertical studs, the nailing surface of the blocking for adjoining panels should be a minimum of 2½ width to provide proper fastener edge distance in the sheathing and blocking. However, unlike framing members, blocking can be installed *flatly if it provides the minimum penetration depth for the fasteners.* Flat installation of blocking provides more nailing surface and better edge distances.

Fig. 3.24 - 3 Inch Blocking

When blocking is installed flatly, a minimum thickness of 1½-inch lumber should be used to nail sheathing with 6d and 8d common nails. Larger nails, like the 10d common, require 1¾-inch thick lumber to provide the full strength of the nail. When 1½-inch flat blocking is used for 10d common nails, shear walls will lose 16 percent of their strength.

Blocking is also provided in shear walls when shear walls are designed with openings. Blocks are installed between the studs in line with the top and bottom of the openings. Metal straps are nailed to the blocks to reinforce the opening. These metal straps usually require 2½-inch minimum width blocking for the 2 rows of 16d common or sinker nails. When the metal straps are fastened with 16d common nails, the blocking must also be at least 2 inches thick. When 1½-inch flat blocking is used for 16d common nails, opening reinforcement straps will lose 23 percent of their strength. (Fig. 3-25 &Fig. 3.26)

Fig. 3.26 – Blocking for Reinforcement

Fig. 3.25 Reinforced Window Openings in Shear Wall

PROPERLY LOCATE THE HOLDOWN STUD

The length of a shear wall is measured horizontally along the sheathing between wall ends or the framing members with holdown devices. Studs for holdown devices should be located as far apart as practical. Framing members for holdown devices should not be notched for larger obstructions like plumbing or countersunk for washers or bolt heads.

Fig. 3.27 - Too Close to Wall

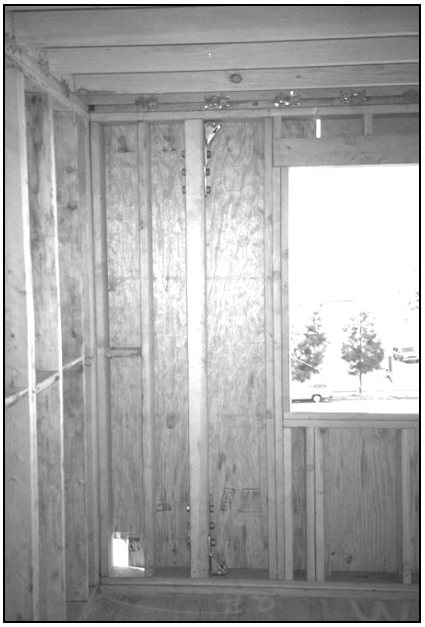


Fig. 3.28 -Too Far From Shear Wall End

Fig. 3.29 - Acceptable Holdown Location for Shear Walls at Corner

USE THE PROPER LUMBER GRADE & SIZE OF HOLDOWN STUDS

When an engineer designs the connection of a holdown device to a framing member, the grade and size of the lumber helps determine how much uplift the framing member can take. For example, "*Construction*" grade 2 x 4 studs can take a maximum 4,540 pounds of seismic uplift. "*Stud*" grade 2 x 4 studs can take only 3,140 pounds. The maximum seismic uplift for "*Stud*" grade 4 x 4 studs is 7,330 pounds. The grade of douglas fir-larch for the holdown stud can determine the available strength of a holdown devices. The shaded portions in Table 4 show when the lumber grade or species controls the allowable value.

When holdown devices are installed on new framing members, contractors and inspectors should verify that the proper grade and size of lumber is used. Otherwise, the holdown may be attached to a framing member that is too weak to resist the required uplift. This will result in lower shear wall strengths.

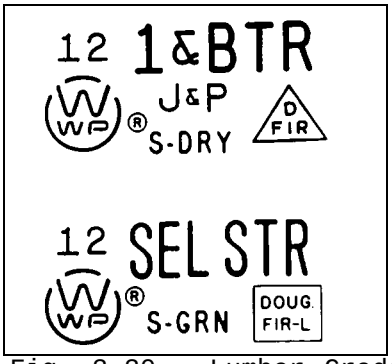


Fig. 3.30 - Lumber Grade

Holdown Product	Stud Size	Douglas Fir-Larch Grade	Catalog Value	Tension, lbs	Compression, lbs		
				Net Section	8 Ft. Stud	Sill or Sole Plate	
						Hem fir	DF-L
HD 8A	4 x 4	No. 1	7,460	12,078	7,695	4,961	7,656
		No. 2		10,288	7,209		
		Construction		7,753	6,840		
		Standard		4,473	6,327		
		Stud		5,905	5,965		

Table 4-Effect of Lumber Grade on Holdown Capacity

AVOID MECHANICAL PENETRATIONS

Many wood frame residences have poor coordination of structural and mechanical installations. Structural designs are completed and approved long before mechanical subcontractors begin to design their systems. Residential mechanical designs often call for penetrations in shear walls. These penetrations can seriously weaken shear walls and stricter notching and cutting limits should be followed than given in the building code for non-shear walls.

As a result of buildings damaged in the Northridge Earthquake, the City of Los Angeles amended its building code to provide stricter limits on mechanical penetrations in wood frame shear walls. These limits effectively remove large electrical conduits, plumbing and heat vents from wood frame shear walls. The following code section and illustration from the Los Angeles Building Code show the recommended limits.


Fig. 3.31 – Unregulated Penetrations

Fig. 3..32-Regulated Penetrations

"2314.5.8 Mechanical Penetration of Wood Shear Walls and Plate Members. The maximum accumulated length of openings in a shear wall shall not exceed 20% of the wall length. Plumbing, electrical, and other mechanical penetrations of the top or bottom plate framing members shall be limited to Figure 23-1-Y-1.

EXCEPTION: Openings or penetrations may exceed this amount where designed and shown on the approved drawings."

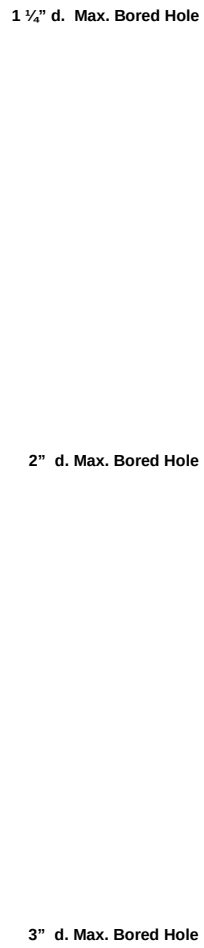


Fig. 3.33 - Non-Engineered Limits for Mechanical Penetrations

Fig. 3.33- Non-Engineered Limits for Mechanical

EVALUATE EXISTING LUMBER

Both the existing and new framing should be free of wood decay. Wood decay is frequently referred to as dry rot. This is a misnomer. Rotted wood may be dry when it is found, but wood actually rots when it is too wet. Fungi that feed on the carbohydrates, cellulose, and lignin that make up the wood primarily cause rot. Such fungi are always present in wood but require high moisture content to become destructive. When wood dries out, the fungi cease to deteriorate the wood fibers. (Fig. 3.34)

When the retrofit work is being performed, the contractor should check for sources of water intrusion and wood -earth clearances. Water should not continuously saturate wood and any wood should be at least 6 inches above any soil. When existing soils are regraded to provide proper wood-earth separation, contractors should be careful not to create new drainage problems or undermine any existing footings. If adequate separation between earth and wood cannot be provided, the contractor should seek the advice of the building official and engineer or architect.

Fig. 3.34 – Wood Decay

Termites, powder post beetles, and other animal organisms can also seriously weaken a structure. Infestation should be treated by a properly licensed and experienced pest control service before the retrofit work begins. Damaged wall framing should be removed and replaced. (Fig. 3.35)

Fig. 3.35 – Termite Damage

PROVIDE ADEQUATE VENTILATION

Adequate ventilation is one of the best ways to minimize potential wood decay in the crawl space. Unless the crawl space is mechanically ventilated, the UBC requires 1 square foot of vent openings in the cripple walls for every 150 square feet of under-floor area. To provide cross ventilation, these openings should be spaced evenly on at least two sides of the crawl space. New sheathing should not reduce or cover existing ventilation openings. Additional ventilation should be added when wood decay is present under pr

Fig. 3. 36 – Crawl Space Ventilation

HOW TO INSTALL THE SHEATHING

USE THE SPECIFIED WOOD STRUCTURAL PANEL

All types of wood structural panel sheathing have the same allowable shear strengths in the UBC. Wood structural panels include all veneer plywood, composite panels, oriented strand board and waferboard. The most common structural panels are plywood and oriented strand board. When the term *"wood structural panel"* is specified, the contractor may use oriented strand board or plywood panels of the required thickness and grade.

ORIENTED STRAND BOARD

Oriented Strand Board (OSB) is a mat-formed panel product made of strands bonded with exterior type resins under heat and pressure. OSB panels consist of four or five layered mats. Most mills use uniformly thick strands up to 4-1/4" long and 1" wide. Exterior or surface layers consist of strands aligned in the long panel direction. Inner-layer layers consist of cross or randomly aligned strands. OSB's strength comes mainly from the uninterrupted wood fiber, interleaving of the long strands or wafers and degree of orientation of

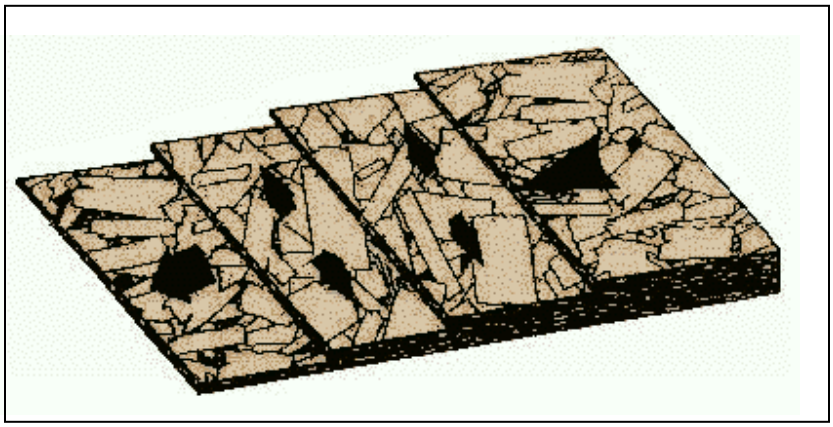


Fig. 3.37 Oriented Strand Board Panel Construction

wafers or strands in the surface layers. (Fig. 3.37)

Question: *Can I substitute oriented strand board for plywood sheathing?*

Answer: Some designers will specify plywood panels for sheathing because oriented strand board expands more than plywood when exposed to moisture. Wetting and expansion can cause fasteners to fracture the surface of the sheathing. Fasteners whose heads are below the surface of the sheathing due to panel expansion will cause premature failure of the shear wall during seismic loading. *When plywood is specified, no substitutions of the less costly OSB should be made without the approval of the structural designer and local building department.*

Professional engineers and architects can and often should design to more than the minimum standards of the building code. When they do, their specifications must be followed. For example, California law states that licensed architects are not responsible for damages caused by unauthorized changes to their plans or specifications. This provision includes changes made by plan reviewers and building inspectors without the architect's consent.

PLYWOOD

Plywood is a panel of laminated veneers (plies) constructed in an odd number of layers. Layers may consist of one or more plies laminated with parallel grain direction. Each layer is positioned perpendicular to the adjacent layer to equalize strain, reduce splitting, and minimize warping. Outer layers generally have the outer layers oriented parallel to the long dimension of the panel. Plywood must have a minimum number of plies and layers for each thickness range. For example, 15/32 inch Structural 1 plywood must have at least 4 plies and 3 layers. Non-Structural 1 plywood of the same thickness can have 3 plies. (Fig. 3.38)

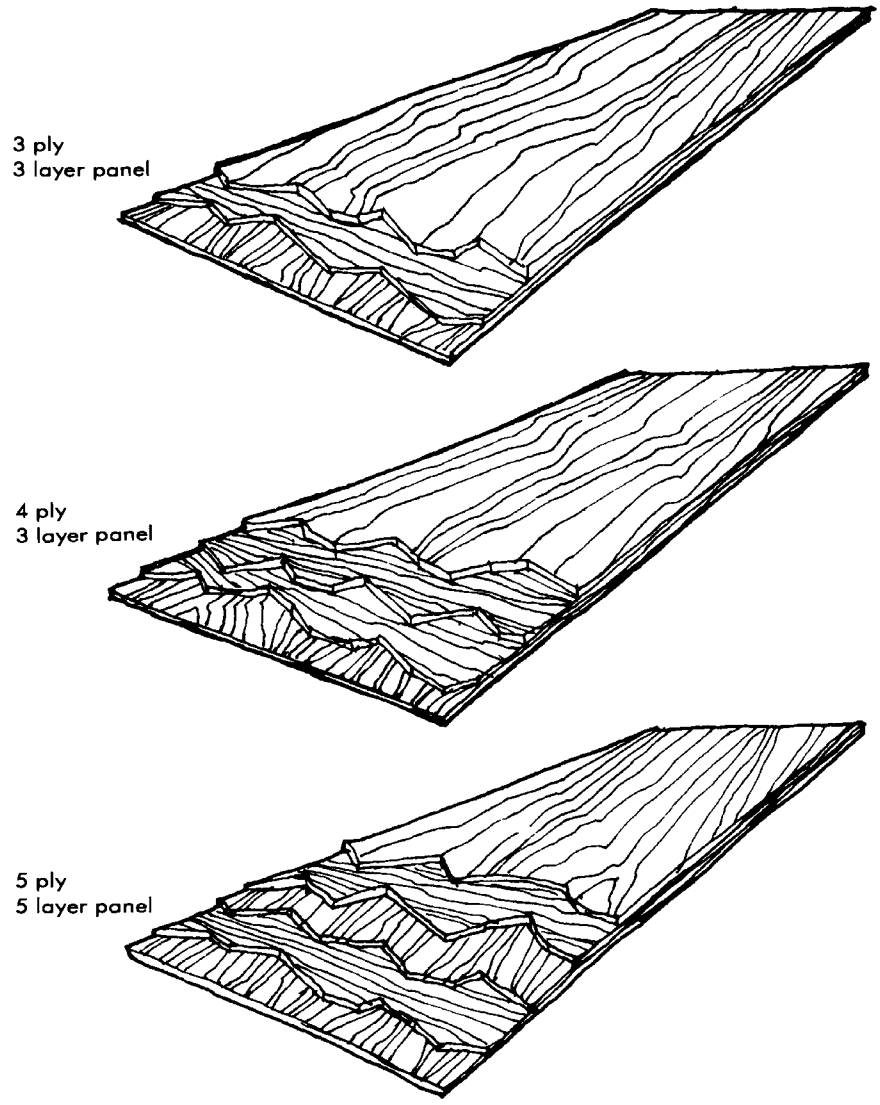


Fig. 3.38 - Plywood Panel Construction

USE THE PROPER THICKNESS & NUMBER OF PLIES

Normally, the strength of shear walls sheathed with wood structural panels comes from the strength of the sheathing fasteners. However, instead of fastener failure, some shear walls constructed with 3/8-inch plywood tore at their inner ply seam during the Northridge Earthquake. This is the first time this type of failure was documented. Using thicker panels with additional plies should allow fasteners to reach their strength limit before the sheathing prematurely tears.

The minimum recommended thickness for wood structural panels is 15/32 of an inch. For this thickness, both four-ply and five-ply plywood panels are commonly available. Five-ply panels provide five plies and five layers while four-ply panels provide four plies and three layers. The more plies and layers that are used in plywood, the more overlapping occurs of defects and inner ply seams. For this reason, some prescriptive standards recommend the use of five-ply panel construction for plywood.

The following panel information was furnished by a major plywood wholesaler and conforms to UBC Standard 23-2 (PS 1-83).

- ☐ 3-ply panel construction is used on 3/8 inch Structural 1, 3/8-inch C-D Exposure 1 and ½-inch C-D Exposure 1.
- ☐ 4-ply panel construction is used on ½-inch Structural 1 (Southern Pine) and 5/8-inch C-D Exposure 1
- ☐ 5-ply panel construction is used on ½-inch Structural 1 (Douglas Fir) and 5/8-inch Structural 1.

The panel thickness shown is nominal. Use 3/8 for 11/32, ½ for 15/32 and 19/32 for 5/8-inch thickness.

Structural 1 plywood in ½-inch thickness is normally available in 4-ply (Southern pine) panel construction because it is less expensive than the 5-ply (Douglas fir). C-D Exposure 1 allows 3-ply in 5/8-inch thickness under UBC STD. 25-9 but manufacturers typically construct the panel with 4 plies to obtain the required thickness.

USE THE PROPER PANEL GRADE

The recommended panel grade for shear wall construction is Structural 1. Structural 1 is the premium grade of "CDX" and OSB panels. Structural 1 Rated Sheathing has increased cross-panel strength and shear properties and all plies use special improved grades. The allowable panel rigidity of Structural 1 is almost twice other structurally rated sheathing. Because of its properties, Structural 1 shear walls are ten percent stronger than other similar fastened structural use sheathing. (Fig. 3.39)

The common phrase "CDX" refers to a plywood panel constructed with exterior glue that has "C" grade veneer on its face and "D" grade veneer on its back. This typical construction panel is used for subfloors and roofs. Roofs and floors generally have several panels resisting the seismic forces and therefore require lower shear strength. In contrast, shear walls generally use few panels to resist these same forces and the demand on individual panel strength and stiffness is greater than floors or roofs. *For*

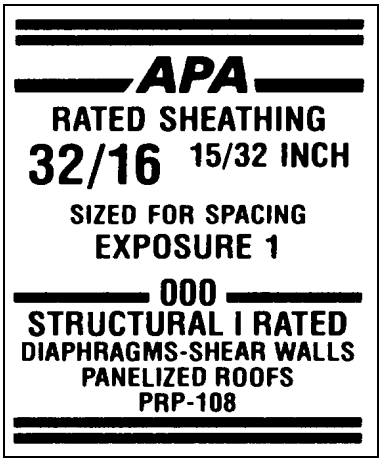


Fig. 3. 39 – Panel Grade Stamp

retrofit work, remember to install each panel with the grade stamp visible for the building inspector.

LOCATE PANEL ON THE CENTER OF FRAMING MEMBER & BLOCKING

Panel edges should be centered on all framing members with a 1/8-inch space between them. The spacing allows for future panel expansion and contraction from moisture and temperature changes. If panels are not properly spaced, expansion will cause buckling. Buckling reduces shear wall performance and can damage wall finishes.

Panel edges should be centered on framing members and blocking to provide proper fastener edge distance in both the lumber and sheathing. The greater the fastener edge distances in the lumber and sheathing, the better the shear wall will perform. Fasteners installed too close to the edge of the sheathing, blocking or framing member have no value.

Question: *Do I Need to Install the Sheathing Perpendicular to the Framing Members?*

Answer: Unlike unblocked floor and roof diaphragms, shear wall strength values in the UBC do not change with orientation of the panel. Either vertical or horizontal placement of the individual panel is acceptable. Most panels are installed vertically to avoid the added expense of blocking. (Fig. 3.40)

Question: *Can I Place the Sheathing on the Inside of the Wall?*

Answer: Sheathing for shear walls may be placed on either the interior or exterior face of the wall framing. Wood structural panel sheathing is usually placed on the exterior for new construction and the interior for retrofit work. For new construction, work of other trades, like insulation and electrical is generally easier when the interior is accessible. For retrofit work, the interior wall surfaces are usually cheaper to replace. The shear wall will have the same strength with the sheathing on either side of the wall.

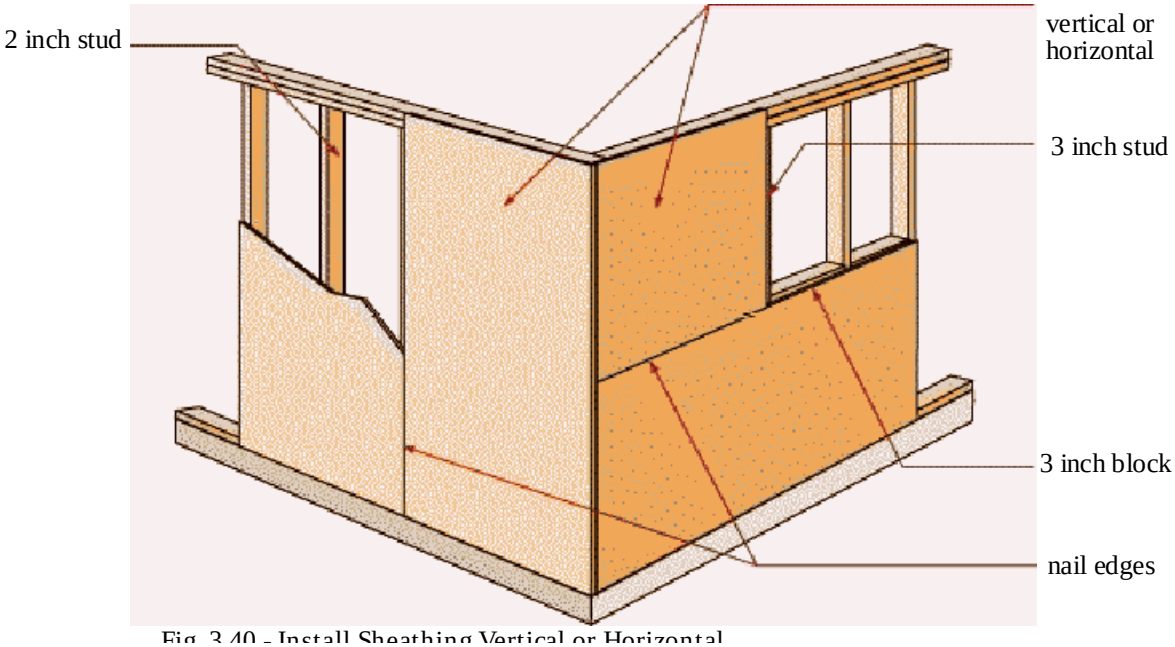


Fig. 3.40 - Install Sheathing Vertical or Horizontal

USE THE PROPER SIZE PANEL

Although the Uniform Building Code does not prescribe minimum dimensions for individual panels on shear walls, a minimum width of 24 inches is recommended to prevent any one local defect affecting performance. This criterion is used for floor loads and is recommended for shear walls.

To follow the 1997 UBC recommendations of 2:1 aspect ratios in Seismic Zones 3 and 4, contractors should always install at least one full 4' x 8' panel on any standard eight-foot high shear wall. When the length of the shear wall exceeds four feet, the end panels should be at least 24 inches.

MARK LOCATION OF STUDS ON PANELS

Retrofit work is usually done from one side of the wall. Panels are held in place with a few nails until volume nailing is done later. Unlike new construction, the number of fasteners that do not properly connect to the framing members or blocking cannot easily be determined after the sheathing is in place. To reduce the chance of improper fastening, contractors should mark the center of all framing members, blocking and holdown end studs during sheathing installation. After all panels are in place, a "chalk" line can be snapped on the panels, which makes proper volume fastening easy.

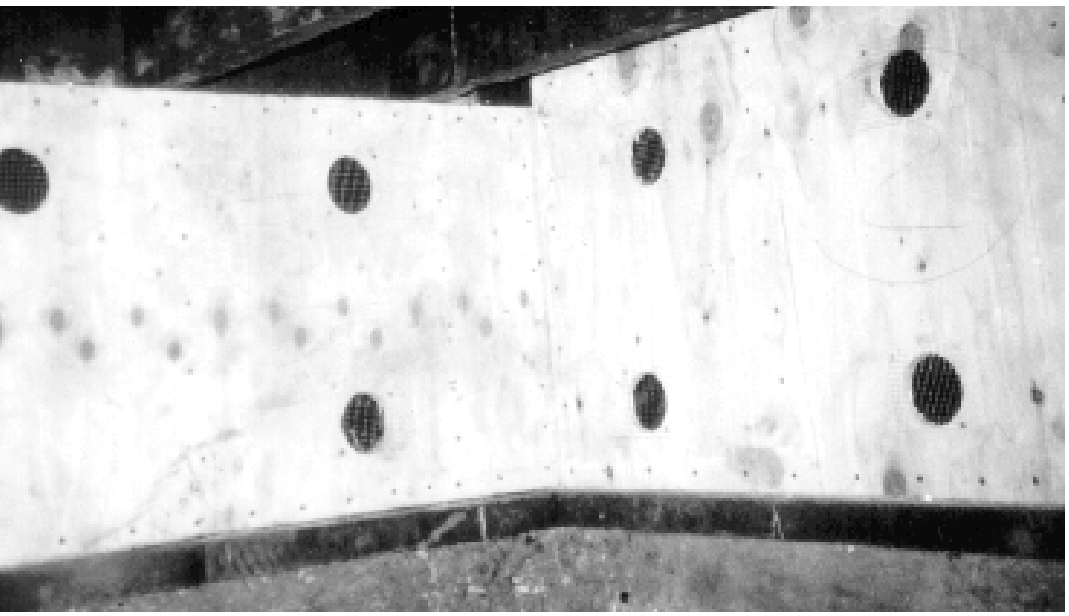
MAINTAIN FIRE RESISTIVE AND SOUND-RATED CONSTRUCTION

When retrofit work replaces existing wall finishes, any fire resistive construction must be maintained. One-hour fire resistive and sound-rated construction is required at walls separating dwelling units in the same building. One-hour fire-resistive construction is also required throughout three story apartments and when two story apartments have more than 3,000 square feet on the second floor. Some apartments may also use two-hour walls to get more allowable floor area. When these conditions exist, all required components of the wall assembly must be replaced. The addition of plywood or OSB panels will not affect the fire rating when attached directly to the framing and covered with the appropriate fire-resistive materials.

PROVIDE VENTILATION AT CRIPPLE WALL SHEATHING

Many older homes do not have building paper under their horizontal siding around the crawl space. This permits water to enter the cripple wall stud cavity. *Circular ventilation holes should be cut in the sheathing when new sheathing is placed on the inside face of the cripple wall.* Prescriptive standards specify the size and spacing of the ventilation holes. The holes will permit water vapor to escape and will permit inspectors to observe and test anchor bolts. Screens should be installed over the ventilation holes to prevent animals from nesting in the newly sheathed stud cavities. (Fig. 3.41)

New sheathing should not block existing vents. Where sheathing must be placed where a ventilation or other opening is located, cut an opening for the vent, install blocking around the vent opening and extend the length of shear wall the width of the vent opening to the nearest stud.



ple Wall Ventilation

HOW TO INSTALL THE FASTENERS

USE COMMON NAILS

Nails are the preferred fasteners for several reasons. They cost less to install than screws and are easier to install in volume due to pneumatic tools commonly known as "nail guns". Engineers prefer nails because they are generally more ductile than screws. Better ductility mean better absorption of seismic energy. When screw withdrawal properties are desirable, such as for floor sheathing, ring-shank or screw-shank nails can be used instead.

Most structural designers specify common nails because of their improved strength and stiffness over box, cooler or sinker nails. Common nails have larger nail shank diameters than other nails. Although hot-dip galvanized box nails may be used for plywood sidings, *common nails are recommended to fasten wood structural panel shear walls.* (Fig. 3.42)

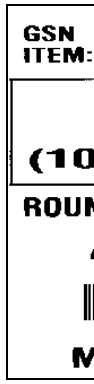


Fig. 3.4
Nails

Hand driven nails typically come in boxes labeled with the nail type. Boxes with nails for nail guns sometimes show only the length, diameter and finish. *To verify the use of common nails, contractors and building inspectors must be familiar with nail diameter requirements.* For example, if a gun nail box says 2-3/8 x.113 Smooth instead of 2-3/8 x.131 Smooth, the fastener is a 8d cooler nail instead of the 8d common. This is a common construction error. Nail sizes and diameters are shown in the Appendix.

USE THE PROPER LENGTH OF COMMON NAIL

Shortened 10d common nails, commonly referred to as ***short or plywood nails***, come in three lengths: 2-1/8, 2¼ & 2-3/8-inches. Only 11/32-inch thick panels can use the shortest nail, 2-1/8-inch. Panels with thicknesses from 3/8-inch to 15/32-inch can use the 2¼-inch length nail. Panel thicknesses from ½-inch to 19/32-inch require the 2-3/8-inch length nail. Panel thickness equal to 5/8-inch or thicker must use the full length 10d common (3 inches).

Question: *Can I Use Shortened 10d Common Nails?*

Answer: Unless otherwise specified, shortened 10d common nails, may fasten wood structural panels in shear walls if they meet the minimum penetration requirements. All nails must provide a minimum of 12 diameters penetration into the framing member or blocking.

Because of their shallower penetration, short nails are less likely to split framing members but are more likely to withdraw. ***Check with the structural designer before using these shortened nails.***

WHY COMMON NAILS ARE IMPORTANT

Because the head sizes of common and box nails are nearly identical, wood structural panel sheathing fastened with these nails will reach the same ultimate strength. The advantage of using common nails to fasten sheathing is generally stiffness and not strength. Common nails have less slip than box nails due to their increased shank diameter. Because shear walls must provide both strength and stiffness, the use of box, cooler or sinker nails will reduce the performance of the shear wall.

UBC Table 23-I-G, which uses stiffness to determine the allowable load values, can be used to make the following stiffness comparison. For sheathing, four common nails provide the same stiffness as five box or cooler nails. When shear walls are constructed with box, sinker, or cooler nails, it will take 25% more nails to make up the difference. However, additional nailing must follow the requirements for minimum spacing and framing member sizes.

When additional nailing creates spacing of 6d or 8d at 2 inches on center or 10d at 3 inches on center, 3 inch nominal width framing members are required at all adjoining panel edges. When the original common nail spacing was equal or less than 6d at 2 inches, 8d at 2½ inches or 10d at 3 inches, additional nails cannot be used because of minimum spacing requirements. In these cases, additional sheathing must be provided and is usually installed on the other side of the same wall. *Remember, it is easier in the long run to do it right the first time.*

COMPARISON OF COMMON VS. BOX NAILS

Length, inches	Shank Diameter, decimal inch		Minimum Spacing and Penetration, inches		Allowable Lateral Load, pounds		
	Common Nail	Box Nail	Common Nail	Box Nail	Common Nail	Box Nail	Box vs. Common
2	0.113	0.099	1¼	1c	63	51	**0.81**
2½	0.131	0.113	1½	1¼	78	63	**0.81**
3	0.148	0.128	1e	1½	94	76	**0.81**

Table 5 - Performance Losses for Nail Substitutions

USE FULL HEADED NAILS

Most Contractors use nail guns to fasten wood structural panel sheathing (Fig. 3.43). The nails used in these tools come in clips that may or may not have full heads. Some manufacturers clip the nail head to form clips with the nail shanks side by side. This arrangement allows more nails per clip, reduces the frequency of reloading and avoids intershank plastic from disabling the tool. Other manufacturers use plastic to hold the individual nails far enough apart to allow for full heads (Fig. 3.44).

Although present building code accepts altered heads, there are good reasons to believe they are not as strong as full headed nails. Examination of plywood shear walls damaged in the Northridge Earthquake showed the importance of nail head size. Shear wall failure occurred at the panel edges. The panel edge either failed by punching through at the nail head or withdrawal of the nail itself in panel buckling. In both cases, the nail head size was a significant element in the mode of failure. The smaller the nail heads size, the easier a panel can buckle off the framing. (Fig. 3.45)

Fig. 3.43 – Sample Nail Gun with Flush Attachment

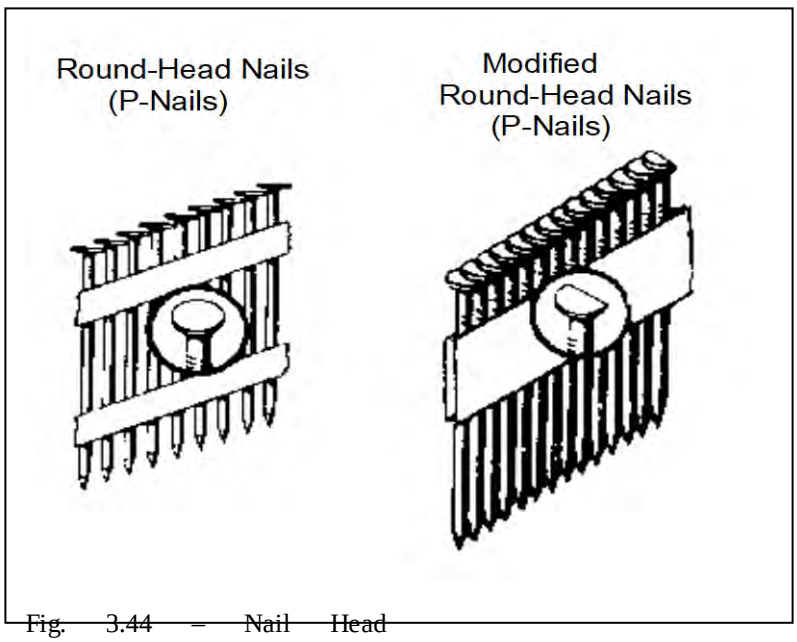


Fig. 3.44 – Nail Head

Fig. 3.45–E

Tests that established the strengths of wood structural panel shear walls used hand driven nails with full heads. Some tests used casing nails. These tests showed that shear walls with 8d casing nails are only 62 percent as strong as ones with 8d box nails. Though the shank diameters of the two nails are the same, the head area of the casing nail is only 27 percent of the box nail. *Smaller head areas provide smaller shear wall strengths.*

INSTALL NAILS FLUSH TO SHEATHING

Some contractors and inspectors have expressed confusion about the actual meaning of the 1994 UBC language "not fracture the surface of the sheathing". The 1997 UBC has clarified the language to state that the "head or crown of the nail is flush the surface of the sheathing." Nails installed with their heads resting on but not into the sheathing can cause problems for roofing and other finishes. Nails should be driven so that the top of the nail is flush and not above the surface of the sheathing.

Because nails will try to pull through the thickness of wood structural panel sheathing during an earthquake, nails should be driven flush with the surface of the sheathing and not overdriven. Overdriven nails reduce the shear wall strength by effectively reducing the thickness of the sheathing. At panel edges, overdriven nails allow easier nail punch-through. At intermediate studs, overdriven nails allow easier panel buckling. Nails are commonly overdriven because of excessive air pressure or too long of a driving pin on the nail gun. Hand driven nails are rarely overdriven unless a soft spot in the framing member or blocking exists where the nail is installed. (Fig. 3.46)

When nailing sheathing, Contractors should operate their nail guns within the manufacturer's recommended pressure range and install flush nailing attachments as required. Inspectors should reject all nails driven below the surface of the sheathing. When the spacing and framing member thickness allow, nails should be added to replace any overdriven nails.

Close
driven

PROVIDE PROPER SHEATHING EDGE DISTANCE

When nails are installed too close to the sheathing edge, the shear wall will fail prematurely during seismic loading. The greater the edge distance, the better the sheathing connection will perform. High-strength diaphragms are created when several rows of nails are placed in wide framing members with large edge distances. Although the 1994 UBC only requires 3/8 inch, the minimum recommended edge distance for sheathing fasteners is ½ inch. This will increase the strength of the connection.

CENTER THE NAILS IN THE FRAMING MEMBERS & BLOCKING

To properly connect sheathing to framing, most nails should be located in the center of the framing member whenever possible. Centering the nail is easy to do on sill plates, sole plates and intermediate studs. Centering nails in the uppermost top plate frequently requires oversized panel sheets. Centering nails in framing members or blocking at adjoining panel edges is impossible. To make up for the inability to center the nails at adjoining panel edges, wider framing members and blocking are recommended at adjoining panel edges.

Missed nails.

Most 8-foot walls today are framed at a height of 8 ft-0¾ inch to allow for the gypsum wallboard on the ceiling. As a result, the common 8-foot sheet of wood structural panel sheathing does not span the full height of the wall. Frequently sheathing panels are installed vertically with one end flush to the bottom edge of the sill or sole plate and the other end centered on the uppermost top plate. This situation cannot easily be fixed by adding 3-inch plates. Thicker plates require longer framing nails that are not readily available and are more difficult to install. The best solution is oversized sheets. Both oriented strand board and plywood come in 9 foot and ten-foot lengths. When these lengths are used, shear transfer connections can be eliminated if nailing is provided to the floor or roof-framing members.

CHECK FOR SPLITTING OF LUMBER DURING NAILING

All fasteners in wood must be installed without splitting of the lumber. There are no exceptions. Existing lumber can be very dry and stiff. If needed to prevent splitting, predrilling of holes at 75% of the nail diameter is required.

REMOVE ALL IMPROPERLY INSTALLED NAILS

To allow for proper inspection, all nails that miss, graze or connect to framing members too close to their edges should be removed prior to inspection. These nails have no allowable value and can mislead the Contractor or Inspector into thinking the job was done right. Since the strength of shear walls sheathed with wood structural panels comes mainly from the fasteners, proper fastener location is of primary importance. (Fig. 3-37)

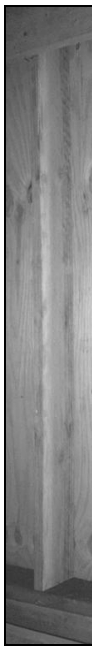


Fig. 3.47

PROVIDE PROPER EDGE NAILING

For the shear wall to reach its intended strength, all sheathing edges of individual panels must be fastened with the edge distance nailing requirements. Intermediate studs must be fastened with the field nailing requirements so that panel buckling does not occur. Remember that the end of a shear wall is where the sheathing stops at either the wall corner or the framing member with the holdown device. *All sheathing must be fastened with the closer edge distance spacing at every framing member that connects to a holdown device.*

The following nail locations apply to all wood structural panels shear walls. "Edge Nail" refers to the closer nail spacing requirement of Uniform

TABLE 5- HOW TO NAIL A SHEAR WALL

- Edge Nail the Holdown Stud(s)
- Edge Nail the Upper Top Plate
- Edge Nail the Sill or Sole Plate
- Edge Nail the Blocking for Individual Panel Edges
- Edge Nail the Blocking for Opening Reinforcement
- Field Nail the Studs Between the Panel Edges

NOTES

4 CONNECTIONS

by Stephan A. Kiefer, C.B.O.

CONNECTIONS RESISTING UPLIFT FORCES

In the *Shear Wall* section you learned that a building must resist two types of forces; shear and uplift. The horizontal forces acting on the top of a shear wall not only create shear forces in the wall but will also create uplift forces at the ends of the wall. Tall and narrow shear walls, in particular, have a tendency to overturn due to uplift forces created when an earthquake (lateral) force pushes the top of the wall. First, we will discuss those connections used to resist uplift forces. (Fig. 4.1)

The shear wall's tendency to overturn may be resisted by its own weight or in combination with the weight of the structure above it. However, when the uplift forces exceed the given weight on or in the wall, additional resistance must be applied. This is done with the installation of metal hardware typically identified as a holdown. There are no prescriptive requirements in the Building Code for the installation of these holdowns. The engineer or architect will specify the installation of holdowns when anticipated uplift forces exceed gravity loads on the wall. *Simply put, the architect or engineer specifies when the installation of a holdown is required.*

Holdowns transfer uplift forces from the end of the wall through a floor to a wall or foundation below. When an earthquake shakes a shear wall back and forth, the shear wall will experience uplift forces on both ends, one end at a time. It is for this reason that holdowns are typically required on both ends of a shear wall and are connected to the end stud or post of the shear wall. The added post is better able to resist the tension load from uplift and the simultaneous compression load at the opposite

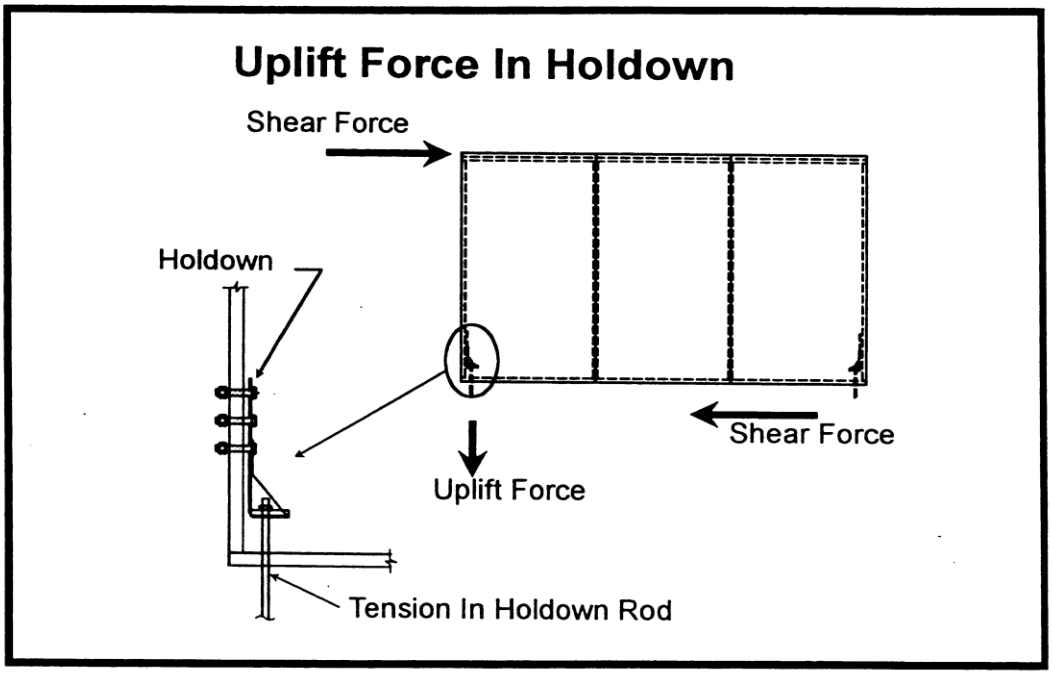


Fig. 4. 1

Fig. 4.2 Floor-to-Floor Holdown

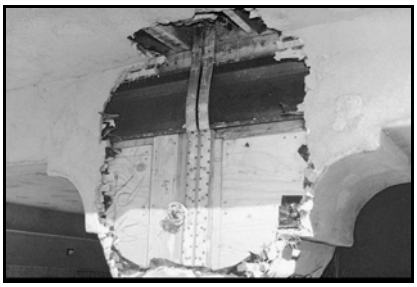


Fig. 4. 3 Improperly Bent Strap

Fig. 4.4 – Proper Installation

TYPES OF HOLDOWNS

Holdowns that connect a shear wall to the foundation are bolted, screwed or nailed to the end stud or added post. Retrofit holdowns are anchored to the footings using a threaded rod that is connected to the holdown. The other end of the rod is adhesive set into a hole that is drilled into the foundation concrete. This rod transfers the uplift force from the wall down into the foundation. This minimizes the wall's tendency to overturn.

Holdowns that connect two walls through a floor come in pairs; one above and one below. The holdowns are bolted, screwed or nailed to their respective end stud or added post. The uplift forces are then transferred from the wall above to the wall below through a threaded rod that is bolted to the holdowns. (Fig. 4.2)

Similar to bolted holdowns, metal straps can be used as holdowns to connect the end studs or added posts below the floor. The strap must be long enough to pass through the floor framing and be attached to the end studs or added posts so that the required number of nails or bolts are provided between the strap and the end stud or added post both above and below the floor. The strap should also be taut and straight to reduce slippage (Fig. 4.3).

IMPORTANCE OF PROPER INSTALLATION

To better understand the importance of properly installed holdowns, consider a tall and narrow shear wall that is 8 feet tall and 2 feet 3 inches wide (height to width ratio of 3 ½ to 1). By applying an earthquake induced horizontal load at the top of the wall, the wall will begin to overturn. For every one inch that the bottom, left corner of the wall goes up, the upper, right corner will move laterally a distance of 3 ½ inches.

Cyclic testing of wood shear walls has shown that lateral movement of as little as 2 inches can cause loss of vertical support and therefore, cause building collapse. Accounting for the height to width ratio of 3 ½ to 1, this means that if a holdown at the bottom left corner of a shear wall slips as little as 5/8 inch up, the building could suffer significant damage and possible collapse!.

Proper installation becomes even more critical when you consider that even a properly installed holdown will tend to allow some upward movement. This inherent deflection can be attributed to:

1. Localized crushing of the wood fiber around the fasteners
2. Crushing of the sill or sole plate under the end stud.
3. Stretching of the metal holdown hardware.
4. Random nut spin or thread stripping during the earthquake.
5. Bending of the fastener (nail, screw or bolt)
6. Wood shrinkage
7. Additional rotation allowed from one-sided connection

Proper installation is essential. (Fig. 4.4) A number of things can go wrong when installing holdowns. What follows is a discussion of some of the more common problems and how to avoid them.

COMMON HOLDOWN INSTALLATION ERRORS

Holdowns should be installed as specified on the plans and following the manufacturer's installation instructions. Substitutions of holdown hardware require the prior approval of the building department and the design professional (engineer or architect). An errant substitution may not provide the same resistance to uplift as originally intended.

When new holdown posts are specified, such as a 4x4 or 4x6, you should not substitute the specified post with a doubled stud. The allowable strength of a holdown is partly based on the cross-sectional area of the end stud. The strength of the holdown is generally reduced by attaching it to two 2x studs (3 inches) instead of the specified solid post (3 ½ inches). (Fig. 4.5)

When nailing on straps used as holdowns, the minimum required edge distance must be maintained. The minimum required edge distance depends on the size of nail used. Nails should be installed no closer to the edge of the wood member than ½ the minimum required embedment depth of the nail (see Table 23-G of the Uniform Building Code). For example, if the nail's minimum embedment depth is 1-3/4 inches, the nail should be installed no closer than 7/8 inch from the edge of the wood member. (Fig. 4.6)

Shear wall end studs or posts should normally be one full piece for the height of the wall. This is necessary because the end stud or post must be capable of resisting tension due to the uplift forces. Otherwise, additional connections will be needed inside the wall to transfer the uplift forces.

When plans specify the installation of new posts in an existing or new wall, the posts should be installed at the ends of the wall. As you now know, tension or uplift loads occur at the ends of a shear wall. Unless otherwise approved by the engineer or architect, holdowns should be located as close to the ends of the shear wall as practical. (Fig. 4.7)

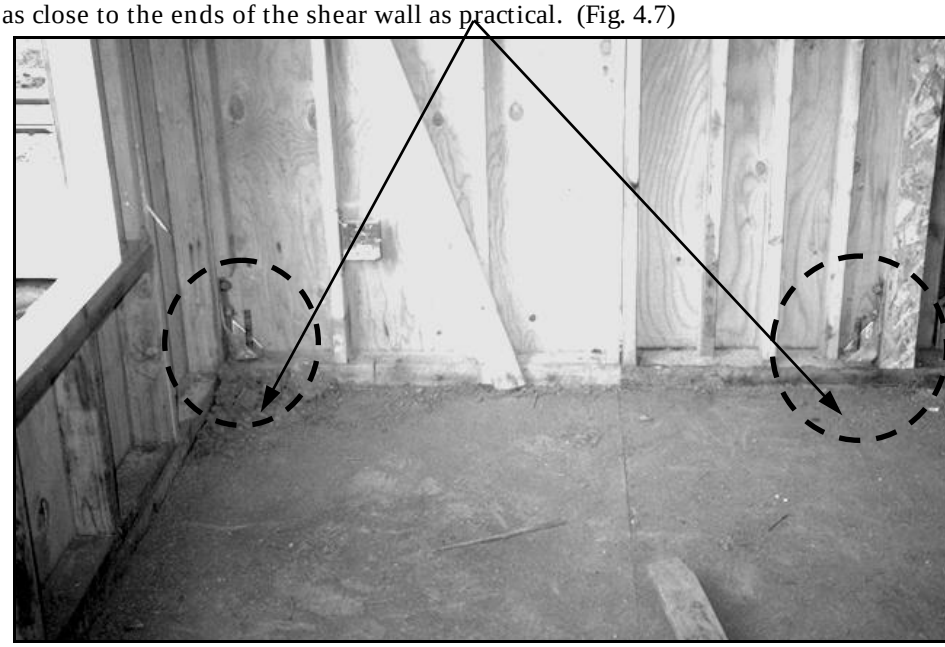


Fig. 4.7 Holdowns at Each End of Shear Wall

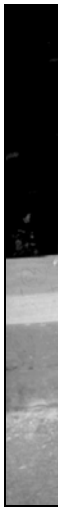


Fig. 4

Fig. 4.6

INSTALLATION ERRORS FOR BOLTED HOLDOWNS

- **Improper End Distance**

With respect to the holdown location on the post, the bolts attaching the holdown to the post should be located per the manufacturer's installation instructions. In general, the first bolt should be at least seven bolt diameters from the bottom of the post. This minimizes the chances of the bolt ripping right through the end of the post during an earthquake (Fig. 4.8).

- **Oversized Bolt Hole**

The post bolt holes must not be oversized. If the hole is bigger than the bolt, the bolt will move before it engages the wood and will be much more likely to split the post. The building code allows the hole in the end stud to be a maximum 1/16-inch oversized. The proper drill bit size must be used so that the hole is no larger than 1/16 inch bigger than the bolt diameter (Fig. 4.9).

- **Undersized Washers**

In addition, washers should always be used where the bolt head or nut bears directly on wood. This typically occurs on the post side that is opposite the holdown. Square plate washers should be used instead of round malleable washers. This will help better prevent the bolt pulling through the end stud during an earthquake (Fig. 4.10).

- **Substitution of Lag Screws for Through Bolts**

When through bolts are specified, lag screws should not be used. A lag screw, even if it is the same diameter, will not have the same strength as a through bolt.

- **Countersinking Nut & Washer**

Post bolts should never be countersunk into the post unless the installed post is at least one size larger than that specified. For instance, if the plan calls for a 4x4 post and it becomes necessary to countersink the bolt head, a 4x6 post should be used. This allows for an additional 2 inches of post thickness in which to countersink the bolt head (Fig. 4.11).

Fig. 4.11 Countersunk Nut and Washer in Holdown Stud

- ## Insufficient Depth of Embedment for Anchor Rods

Holdown rods anchored into the foundation should be embedded as required by the manufacturer or structural design. The rods should only be embedded into sound concrete or reinforced masonry. Unlike a typical anchor bolt, the holdown rod must resist uplift forces. The loads imposed on a holdown rod are generally greater than those imposed on a typical shear wall anchor bolt. Holdown anchors that are not installed to the proper depth and at the minimum edge distance will not perform as intended during an earthquake (Fig. 4.12).

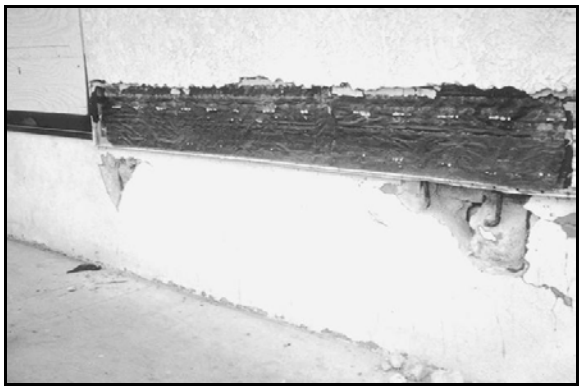


Fig. 4.12 Lack of Embedment for Holdown Anchor

- ## Substitution of Holdown Anchor Type

Wedge or Expansion type anchors should not be substituted when chemical (adhesive) anchors are specified. For holdowns, these anchors do not generally perform as well as adhesive anchors during the cyclic uplift loading caused by earthquakes.

- ## Untightened Nuts

The nut must be tightened securely on the holdown rod. If not properly tightened, the wall will begin to uplift during an earthquake before it engages the holdown. This movement can split both the sill plate and the holdown post. When the nut is not properly tightened, shear wall overturning will cause damage to the building (Fig. 4.13).

Fig. 4.13 Untightened Nut Found in Earthquake Damaged Building

CONNECTIONS RESISTING SHEAR FORCES

A typical wood-framed building has many connections where shear forces are present. All of these connections are links in the shear load path. Just as with the uplift forces, these shear forces must be adequately resisted in order to minimize building damage (Fig. 4.14). No matter how heavy the gravity load, friction alone is not an effective way to create a load path. Remember that the heavier the gravity load, the greater the inertia and resulting shear force.

Two pieces of wood that are butted together can be easily pulled apart if not connected by some type of splice. Similarly, two pieces lying one on the other can be slid past each other if not properly connected (Fig. 4-15). In wood framing, all connections need to have a nail, screw or bolt connecting two pieces together. Proper shear connections are created with combinations of fasteners, blocking and hardware such as framing anchors.

FASTENER TYPES IN SHEAR CONNECTIONS

For nailed connections to be effective, the nails need to penetrate the wood a minimum depth. To accomplish this, the specified nail length must be used in all wood connections. It is also important to use the proper diameter nail (common vs. box) and avoid splitting the wood while nailing.

Screws should not be randomly substituted for nails. While screws provide superior holding power in tension, they have reduced ductility. Ductility is necessary to prevent brittle fracture during cyclic loading.

Fig. 4.15 Building Damage from Shear Connection Failure during an Earthquake

SHEAR CONNECTIONS IN THE LOAD PATH

There are many breaks in the continuity of a conventional platform-framed building, particularly if it rests on cripple walls. Shear forces created by the earthquake must be effectively transferred through these breaks in order for the load path to be complete. The following elements must connected to each other to develop this complete path.

1. Roof and ceiling must be attached to the top plate(s).
2. Top plate must be attached to the sheathing.
3. Sheathing must be attached to the sole plate.
4. Sole plate must be attached to the floor framing.
5. Floor framing must be attached to the top plate(s).
6. Top plate(s) must be attached to the sheathing.
7. Sheathing must be attached to the foundation sill plate.
8. Foundation sill plate must be attached to the foundation.

When these elements are properly connected, they form an unbroken load path from the roof and floor diaphragms to the ground. Figure 4-16 shows forty-four (44) elements in this shear load path.

NON-STANDARD FRAMING

When evaluating an existing building for possible retrofit, it is important to identify non-standard framing. Balloon framing is one type of non-standard framing. Balloon framed structures were common on the East Coast and Midwest until recently. Some older buildings on the West Coast are also balloon framed. In balloon framing, the intermediate floor framing joists are face nailed directly to the studs. The studs are continuous from top to bottom of the building. This creates a load path discontinuity between the floor diaphragm and shear wall. *When encountering this or any other type of non -standard framing, an architect or engineer should beconsulted.* (Fig. 4-17)

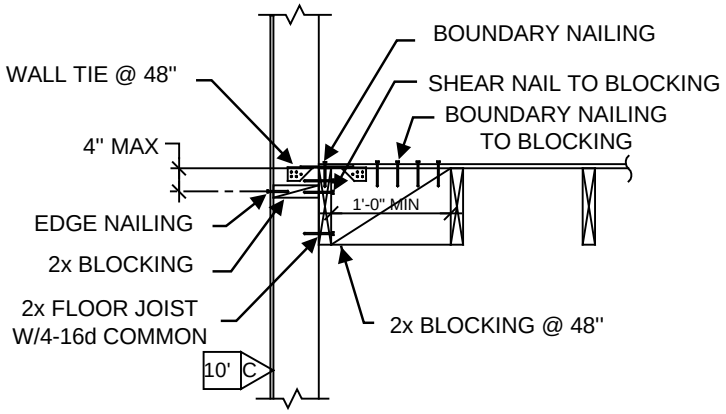


Figure 4.17 Balloon Framing

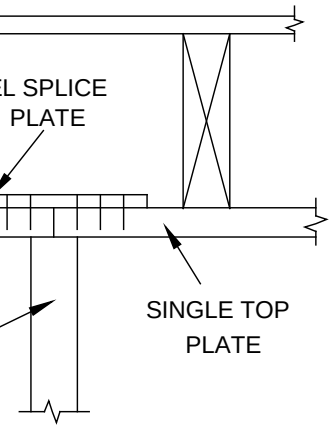
CONNECTIONS AT TOP PLATES

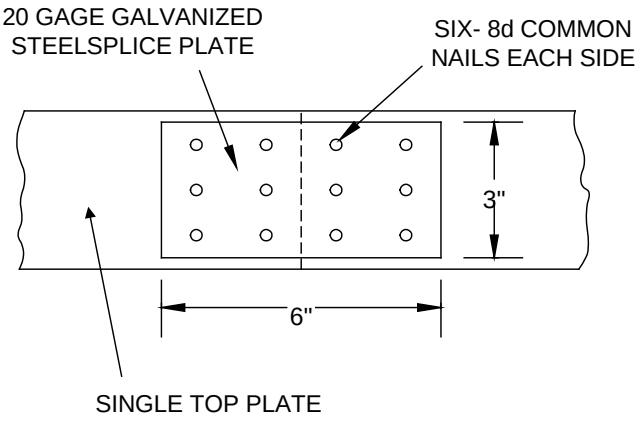
Walls built today usually have doubled top plates on which the roof, ceiling or floor framing above rests. On some older buildings, only a single top plate was installed. The top plate(s) is where the shear wall sheathing is nailed and where the shear forces transfer from the roof, ceiling or floor diaphragm. For adequate transfer of forces, it is necessary to attach the top plate to the rim joist or blocking above.

Code conventional framing requires that each joist be attached to the top plate with 3-8d toenails. This amount of attachment may not be adequate for shear forces in the plane of the wall. Since it is difficult to determine if there is sufficient existing toe-nailing, metal right angle clips (framing clips) should be nailed into the top plate(s) and the rim joist or blocking. This will strengthen the shear connection between the floor framing and the shear wall below. (Fig. 4.18)

These shear connections should be installed at the required spacing along the entire length of the wall. Spacing will depend on the given design value of the clip and the prescriptive or engineered retrofit design that is being used. For shallow 2x6 or 2x8 joists, it may be difficult to attach the clip into the rim joist or blocking and top plate. The use of a pneumatic palm nailer will make this installation easier in difficult access areas. (Fig. 4.19)

Splices in double top plates should be properly lapped and the laps should be well nailed. If a double top plate is notched or cut (say for a plumbing vent), metal straps should be added across the notch to restore its tension capacity. When splices of double top plate are not properly built or if there is only one discontinuous top plate, a metal strap should be nailed across the splice to provide the necessary continuity. (Fig. 4.20)





e Top Plates

CONNECTIONS AT SOLE PLATES

At the bottom of a shear wall, the attachment of the sole plate and the floor decking to the floor framing accomplishes the shear transfer from the shear wall and the floor diaphragm to the floor framing below. When nails or lag screws resist shear, they must be sufficiently long enough to penetrate through the sole plate and floor sheathing into the framing member below. (Fig. 4-21)

For full load values, Table 23-G of the Uniform Building Code specifies the minimum penetration required of nails into the framing member. When the nail penetration falls below Table 23-G values, the allowable load for the nail is reduced proportionally up to 50% of its value. When nail penetration falls below 6 nail shank diameters, the allowable load value is zero. For this reason, nails often cannot transfer shear forces through thick sheathing.

If the wall framing is exposed above the floor, as in new framing that has not yet had plaster or drywall attached, the nails can be installed from above. However, in some retrofit situations, the wall framing above is not (or cannot be) exposed. In this case, it may be possible to add framing clips where the underside of the floor and the rim joist or blocking meets. Short joist hanger nails should be used to attach the clips to the joist or blocking. Longer nails or wood screws should be used to penetrate up through the floor decking and into the sole plate above.

In some multiple story buildings, double sole plates may be encountered. The second sole plate may have been installed to act as a form for poured-in-place lightweight concrete or gypsum sub-floor material. Where this occurs, it is important to maintain a load path through both plates. In new construction, this is accomplished by nailing the first sole plate and second sole plate with a sufficient number of nails specified by a design professional. In existing construction, it may be necessary to use extra long nails or screws through both plates so that the fastener has enough penetration into the framing member below. (Fig.4.22)

Another way of accomplishing the shear transfer from a wall and floor above into the wall below is to use longer sheets of wood structural panels. By spanning full sheets from the rim joist or blocking above to the rim joist or blocking below, the panel serves as a direct load path from one shear wall to the other. This reduces the number of links in the chain and eliminates the need for framing clips. Remember to install the four rows of nails (as illustrated) to provide a load path from the floor diaphragm as well as the wall above and always provide the recommended gap between panel edges to allow for expansion. New construction requires ev ocking. (Fig. 4.23)

Fig. 4.22 Double sole plates

Fig. 4.2

Fig.4-23

CONNECTIONS AT SILL PLATES


Fig. 4-24 Earthquake Damaged Sill

Because shear loads are cumulative as they work their way down a building, they are greatest at the base of a building. Shear loads are transferred from the shear wall into the foundation through the sill plate. Consequently, the sill plate must be attached to the foundation with anchor bolts or plates. Before the load enters the anchor bolt or plate, it must successfully pass through the sill plate. Sill plates should be in good condition and free from cracks. If a cracked or split sill plate is encountered, it should be replaced before proceeding with the retrofit (Fig. 4-24).

Sometimes existing anchor bolts in the sill plate are too few in numbers or size or are rusted through under the sill plate. Some older buildings did not bolt their sill plates to the concrete stem wall. In these cases, special retrofit anchors must be used to strengthen the sill plate connection. New sill plate anchors are installed in two ways: drilled-in anchors through the sill plate or side plates that connect the sill plate to the foundation concrete or masonry. Side plates are used when there is not enough room to stand a drill motor on top of the sill plate (Fig. 4.25-27).


Fig. 4.25 Mechanical Anchor

Drilled-in anchors come in two types: mechanical and adhesive. Adhesive anchors have the advantage of working in lower strength existing concrete. They are more expensive to install than mechanical anchors and require greater quality control during installation. Mechanical wedge anchors are easier to install but require generally greater concrete strength due to the concentration of stresses at the expansion clip. When sufficient concrete strength exists, either adhesive or mechanical anchors may be used. Generally the strength of both anchor types in concrete is greater than their strength in the wood sill plate.

All anchoring products should be installed per the manufacturer's installation instructions. Some products require special inspection as defined in Chapter 17 of the Uniform Building Code. *Always check with the manufacturer and the local building official to determine if special inspection is required.*


Fig. 4.26 Adhesive Anchor

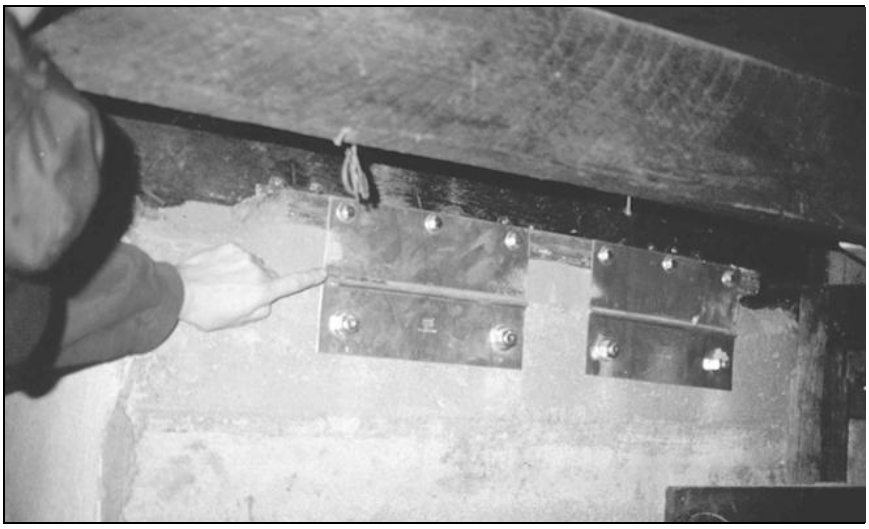


Fig. 4.27 Side Plate to Connect Sill Plate to Concrete Stem Wall

LOCATING DRILLED-IN ANCHORS

- **Provide Proper Edge Distance in the Concrete and Wood**

Drilled-in anchors require a minimum edge distance in concrete. The manufacturer's recommendations will specify the minimum amount required for each diameter anchor. Anchors without sufficient edge distance will fail in earthquakes and sometimes, even during installation (Fig 4.28). When obstructions require the hole be drilled at slight angle, make sure that the bottom of the hole still has the minimum edge distance. This is particularly important when using mechanical anchors. Normally, drilled-in anchors should be installed near the center of the sill plate (Fig. 4-29). This will furnish the minimum required 1-½ bolt diameter edge distance in the wood. For 2 x 6 sill plates, this will generally provide adequate edge distance in the concrete.

Fig. 4.28 Concrete Edge Distance Failure

When foundation walls of a house are located slightly out of position, builders will sometimes adjust the wood wall location. They do this by partially overhanging the sill plate at the edge of the foundation wall (Fig.4-.30). If such a condition is encountered during retrofit, an architect or engineer should be consulted. If the overhang is severe or the required edge distances in the concrete, masonry or wood is not provided, a special repair or connection may be needed to effectively transfer the shear loads.

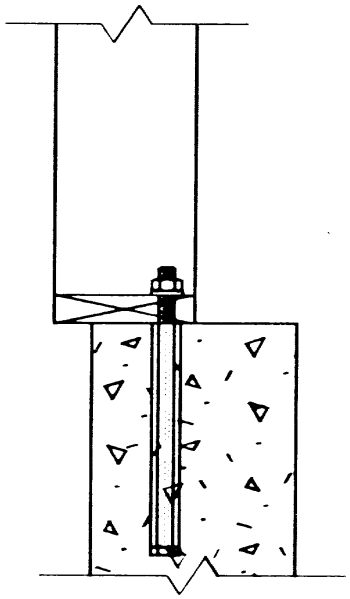


Fig. 4-30 Misaligned Sill Plate

- **Provide Proper End Distance in the Sill Plate**

Additional anchors should be installed within 12 inches but not closer than 7 bolt diameters from the end of each sill plate piece.

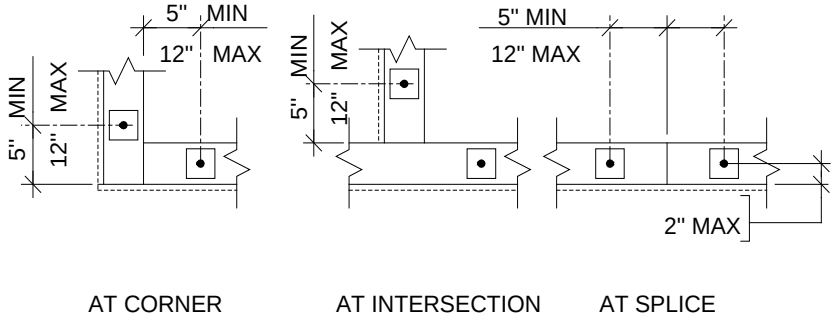


Fig. 4-29 Proper End Distance for 5/8-inch Sill Plate Anchors

- **Provide Proper Depth of Embedment in the Concrete**

To safely resist their shear loads, both adhesive and mechanical anchors need a minimum depth of embedment in the concrete. The manufacturer's recommendations will show the minimum embedment depths required. When holes are drilled deeper than required, nuts and plate washers should be installed on the mechanical and adhesive anchors before they pass through the sill plate. This will prevent the anchor from sinking too deep into the hole. If the anchor settles too deep in the hole, it should be left in place and another anchor installed nearby. When plate washers and nuts are countersunk into the sill plate, the reduced plate thickness weakens the connection (Fig. 4.31).

Fig. 4. 31 Improper Countersinking

- **Use the Proper Length of Anchor**

When edge distance permits, drilled-in anchors can be installed directly through the blocking added for cripple wall strengthening but longer anchors are needed to provide the minimum depth of embedment in the concrete. Longer anchors are also required when sill plates are full two inches thick. This commonly occurs in older buildings (Fig. 4.32).

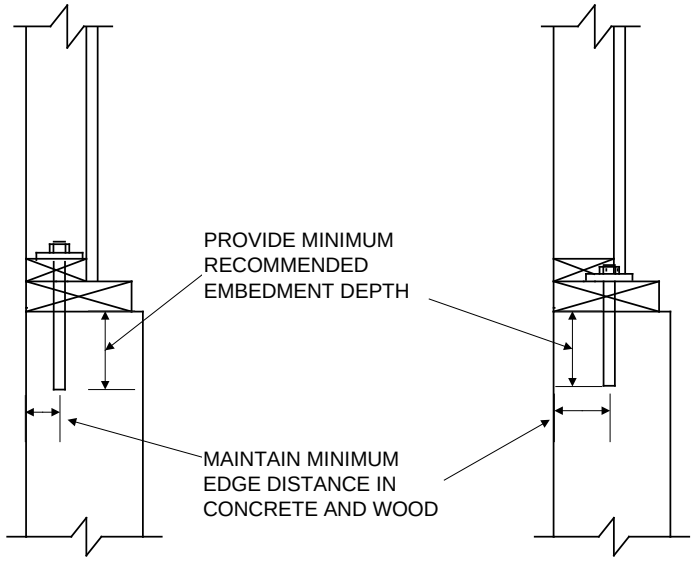


Fig. 4.32 Sill Plate Anchor Options

- **Use Plate Washers**

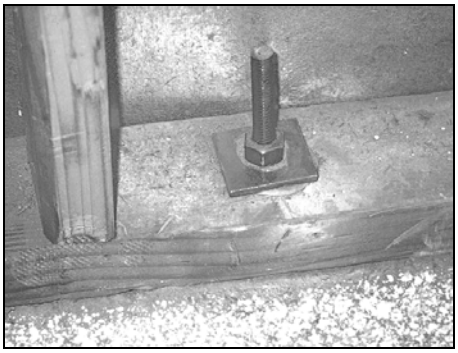


Fig. 4.33 Square Plate Washer

To further reduce the chances of the sill plate splitting during an earthquake, square plate washers should be used instead of round washers. Round malleable washers tend to fold up and split the sill plate during an earthquake, especially when the sill plate hole is oversized. During the 1994 Northridge earthquake, sill plates often split or pulled through anchor bolts. The square plate washer is more effective in creating a good friction connection between the sill plate and the bolt. It also makes tightening of expansion anchors easier (Fig. 4.33).

INSTALLING MECHANICAL ANCHORS

Mechanical anchors attach to the concrete through friction by mechanically expanding or "wedging" against the concrete. These types of anchors are effective if the concrete is in good shape and the minimum edge distance is maintained. The proper diameter hole is essential to allow the anchor to properly engage. Normally it is the nominal diameter of the anchor. Sometimes the bolt will not engage due to air or powder pockets in the area of the expansion wedge. This will be apparent when the bolt will not torque to the required strength. When this happens, the bolt should be abandoned and a new bolt should be installed nearby in a new hole.

Wedge anchors have a required torque to properly set them in concrete. For sill plate anchors, the range is generally 50-120 ft-lbs. The use of plate washers will help reach the required torque without excessive compression of the sill plate

under the washer. *Follow the manufacturer's recommendation for the required torque and use a calibrated torque wrench.*

INSTALLING ADHESIVE ANCHORS

- **Carefully Clean the Hole**

Unlike mechanical anchors, adhesive anchors attach to the concrete chemically; they glue to the concrete. These products usually come in a two-part tube applicator and are readily available. Because the products create a chemical bond between the anchor rod and the concrete, it is extremely important that the hole be properly drilled and cleaned. The product must adhere directly to the concrete surface and not to residual dust that might be left in the hole after drilling. Carefully clean the hole as required by the manufacturer. The hole must be properly brushed and blown out prior to adhesive installation (Fig. 4.34 & 4.35).

- **Use All-threaded Rod**

Although these products chemically bond to concrete, they will NOT chemically bond to the anchor rod (steel). Therefore, threaded rod is required for all adhesive-anchoring systems. This allows the product to engage the threads and create a good mechanical bond to the rod.

- **Completely Fill the Hole in the Sill Plate with Adhesive**

Most adhesive products require holes in the concrete that are oversized 1/8-inch larger than the all-thread diameter rod. This creates oversized holes in wood sill plates because the limit is only 1/16-inch. To remedy this, enough adhesive should be placed in the hole to overflow the sill plate once the rod is installed. This will allow the sill plate to immediately engage the anchor rod during an earthquake and allow it to transfer shear forces directly into the rod, thus reducing the chances of the sill plate splitting (Fig. 4.37).

- **Install the All-thread Rod with the Plate Washer and Nut Attached**

The washer and nut should be placed on the rod prior to installing the rod since the adhesive extruding from the top of the sill plate will make it difficult, if not impossible to install the washer and nut at a later time.

- **Wait Until Fully Cured Before Tightening**

Adhesive anchor installations will need to cure for several hours before they can be tested. Always check manufacturer's requirements for minimum set and cure time. The time will vary depending on the product used and the temperature.

- **Follow Safety Requirements**

A final word of caution on the use of adhesive anchors: *you need to protect workers and the people living in the building from the fumes* . Check with the manufacturer to find out which product is appropriate for the use and what precautions, will be needed. You will learn more about this in the section on *Safety & Legal*


Fig. 4.3


Fig. 4.
Fines


Fig. 4.3

INSTALLING SIDE PLATES

When installing these plates, follow the manufacturer's installation instructions carefully (Fig. 4.37). Unless otherwise approved, lag screws require pre-drilling to avoid splitting the sill plate during seismic loading. Lag screws require pre-drilling even if you intend to use a pneumatic wrench. Be careful not to overtighten the lag screw during installation. This will "strip" out the hole. To prevent damage to the hole, never drive the lag screws with a hammer.

Lag screws require two different diameter pre-drill holes. The larger diameter pre-drill hole is for the solid shank portion of the screw. This hole should be drilled the same diameter as the screw itself. The second hole is the pre-drill hole for the threaded portion. This hole must be smaller than the threaded diameter in order for the lag screw to grip the wood. Required pre-drill hole sizes for both lag screws and nails are shown in the Appendix.

Post

INTERIOR POST TO GIRDER CONNECTIONS

There is a misconception that the strength of the crawl space can be increased by adding gussets, straps, or bracing to the interior posts. In a house with a properly braced perimeter cripple wall, elaborate post connections will not provide any benefit. The posts need only a simple toenail connection at the top and bottom to keep them from shifting during an earthquake (Fig. 4.38).

When seismic strengthening is being performed in the underfloor crawl space, you should inspect the post connections and provide toenails, small straps, or clips only when there is no existing connection. When you are unsure about the condition, have an engineer evaluate it. If the perimeter of the house is properly braced, there should be very little movement at the top of these posts.

PUTTING IT ALL TOGETHER

By carefully following the plans and the manufacturer's specifications and installation instructions, and by following these tips and guidelines, you will significantly reduce the number of weak links in the load path chain. When installing a retrofit, understand the objective. By understanding the load path and realizing the importance of maintaining a complete and continuous load path from top to bottom, you will be able to complete a more effective and possibly a more economical retrofit.

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5 FOUNDATIONS

by Richard Chylinski, FAIA
and Timothy P. McCormick, P.E.

FOUNDATIONS

Let's assume that the retrofit has been done correctly from the roofline to the top of the foundation. The shear walls have the proper thickness of plywood, adequate plys, plenty of common nails, anchor bolts, and hold-downs. Everything has been done correctly, including the connection between the shear wall and the foundation. However, if the foundation cannot resist the forces imposed on it, there is still a problem. As noted, the horizontal force will tend to make the building or wall slide or overturn. If the foundation is not adequate, it will be the weak link in the continuous load path, and the wall or building could be damaged.

In determining whether or not the foundation can resist the horizontal forces that are transferred to it, it is necessary to investigate foundations in terms of type, material, condition, and embedment.

FOUNDATION TYPES

Residential foundation systems can be divided into six general categories:

- No foundation
- Partial foundation
- Post and pier throughout
- Perimeter footing with interior posts
- Continuous perimeter and interior footings
- Continuous footings with a slab floor on grade.

With no foundation, or too small a partial foundation, the horizontal forces in the building cannot be transferred safely into the ground (Fig. 5.1). There is a similar discontinuity in the load path with a post and pier foundation (Fig. 5.2). You will learn more about post and pier systems in the next section, *Retrofitting Post and Pier Type Houses.*

When a building has a continuous perimeter footing, the horizontal force can transfer from the shear wall to footing and then into the ground. Interior supports are usually posts and girders or continuous cripple walls (Fig. 5.3 & 5.4). Unless there are shear walls above, these systems provide vertical support only and are not part of the horizontal force-resisting system. They are simply part of the gravity force-resisting system.

Fig.5.1 – Partial Foundation

Fig.5.2 – Post & Pier Foundation

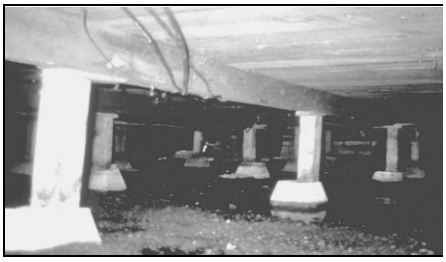

Fig.5.3 –Interior Posts & Girders

Fig.5.4 Continuous Interior Footing

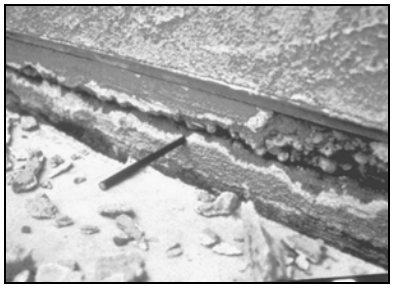

Fig.5.6 –Failure of Two-pour Joint

Contractors frequently pour slabs in a two-step process with the footing being the first pour and the slab being the second pour. (Fig. 5.5) When the joint between the two pours is not properly cleaned and prepared, there will be a poor connection between the concrete layers. The problem is often discovered after an earthquake causes horizontal sliding between the pours. Typical remedies for this condition include installing vertical steel reinforcing dowels that tie the slab to the footing. These remedies must be designed by an architect or engineer.

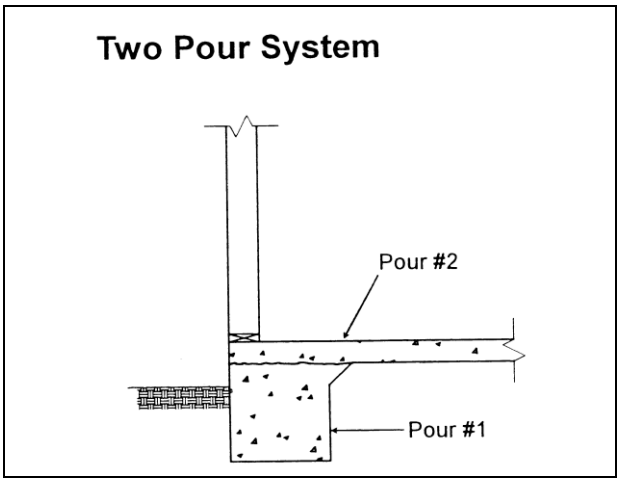

Fig.5. 5

FOUNDATION MATERIAL

The foundation would normally consist of one or more the following materials :

- concrete
- concrete block
- brick
- stone.

If the concrete block is fully grouted and reinforced, it will tend to act as concrete. If it is not grouted or reinforced, it will act as brick or stone

Fig.5.7 – Unreinforced Brick Foundation Wall

Continuous concrete footings and foundation walls are the best material type. This is one reason their presence is required in some prescriptive standards. Expansion anchors require concrete and are not approved for connections to masonry.

Some adhesive anchor products can be used for reinforced masonry. Reinforced masonry is not as strong as concrete but when fully grouted is strong enough to resist the seismic loads of light wood frame buildings. Hollow masonry is usually unreinforced.

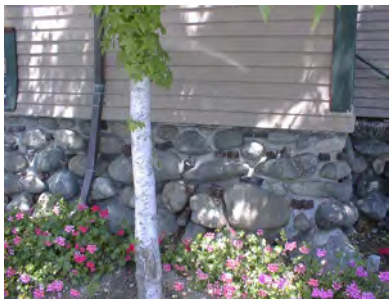

Fig.5. 8- Stone Foundation Wall

When the foundation walls or footings are constructed with any unreinforced material such as stone or pre-1933 brick, retrofitting requires the expertise of an engineer or architect. Many engineers believe that unreinforced masonry materials cannot adequately resist seismic loads. Common retrofit methods for unreinforced masonry foundations include replacement, new parallel systems or strengthening by pneumatically placed concrete (shotcrete or gunite).

FOUNDATI3ON CONDITION

There are two concerns for the foundation condition: deterioration and cracking.

Deterioration

Deterioration of the foundation wall is normally visible to the naked eye. Before beginning work, a visual inspection of the foundation walls can find excessive concrete or masonry cracking and weathering . Mortar in reinforced masonry should be well pointed and tooled. Existing concrete should be smooth and without separation or exposure of stone aggregates. Poorly finished and consolidated concrete frequently suffers later from excessive weathering. If parging or repointing cannot repair the wall, a full foundation retrofit is required. You will learn more about this later in this section.

Fig.5.9 – Deteriorated Mortar Joints in Foundation Wall

Foundation Cracking

When concrete foundation walls are constructed without expansion joints, hairline crackling will normally occur. Cracks that are wider at the top than at the bottom are often caused by expansive soil. When the crack is wider at the bottom than at the top, there is likely a problem with soil settlement. These problems can prevent the seismic loads from safely dissipating through the soil (Fig. 5-11).

Fig.5.10 – Foundation Wall

The effects of expansive soils are best reduced with deepened footings and control of adjacent watering. Keeping roof and surface water away from footings is always a good idea since settlement can also occur with excessive water in the soil. Underpinning, roof gutters with downspouts to yard drains and new concrete paving can help alleviate expansive soil problems. The presence of expansive soils or foundation settlement indicates the need for professional advice. Geotechnical engineers specialize in solving these problems.

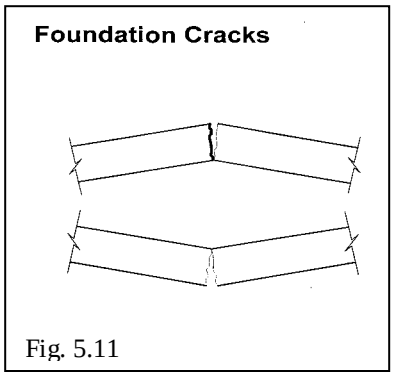

Fig. 5.11

Depending on the size of the crack, concrete cracking can be repaired with various epoxy or cementitious mortars. These products require special inspection and careful quality control by the approved applicator. These products should be used only under the qualified advice of an engineer or architect.

Question: *When is a crack in the footing something to be concerned about?*

Answer: An architect or engineer should be consulted if the crack is greater than 1/8 of an inch, you can see all the way through the crack, or if it appears that the crack was caused by settlement or the thrust of expansive soils (Fig. 5.12).

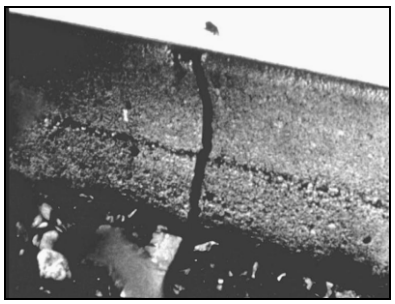

Fig. 5.12 Foundation Wall Crack

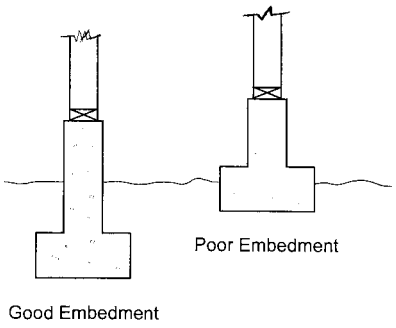

Fig.5. 13

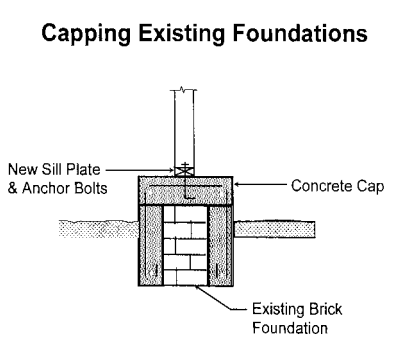

Fig. 5.14


Fig.5.15 Foundation Replacement


Fig. 5.16 Parallel System

FOUNDATION EMBEDMENT

Footings must be embedded deep enough into the ground so that the foundation can safely resist the vertical and horizontal loads imposed upon it. Shear walls impart compression and sliding forces to the footing. Usually the deeper the footings are, the better the soil condition is and the better the foundation can resist these loads. When poor embedment exists, the load path is incomplete and the building can simply slide along the ground surface.

Foundation embedment is measured below the undisturbed ground surface and does not include the depth through loose topping soils that are commonly added for the garden. The minimum required embedment depth for the footing is based on the number of floors supported and the soil condition. If the existing foundation depth is less than 12, 18 or 24 inches for 1, 2 or 3-story buildings respectively or there is evidence of expansive soils, an architect or engineer should be consulted. (Fig. 5.13)

FOUNDATION RETROFIT

Several options exist to retrofit the buildings footings and foundation walls:

- capping
- replacement
- parallel systems

Capping simply means that concrete is placed over or alongside the existing foundation wall. An engineer or architect must specify the reinforcing steel, anchor bolts and connections between the existing foundation wall and the new capping. The embedment of anchor bolts and placement of reinforcing steel generally follow the standards for new construction. For unreinforced masonry, some of the bricks or stones are removed to help interlock the capping to the existing wall. To provide proper curing of the capping, existing brick foundation walls must be well saturated with water before any shotcrete or gunite is installed over them. Capping is popular when owners wish to maintain the appearance of masonry foundation walls (Fig.5.14).

Replacement involves shoring up the building and putting in a complete or partial perimeter footing and stem wall. This method is frequently used to reset houses that fell off their foundation during an earthquake but remained intact (Fig. 5.15) Shoring can be omitted when replacement is done in small sections at a time. The latter technique is popular for occupied structures.

Parallel systems are systems of new structural elements that create a parallel horizontal force-resisting system at the foundation level. These systems are designed by an engineer or architect. The new structural elements are typically located near the exterior walls. A sample system using large concrete columns is show in Figure 5.16.

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6 RETROFITTING POST & PIER HOUSES

by James E. Russell, P.E.

RETROFITTING POST AND PIER HOUSES

This section describes a prescriptive method for the seismic retrofitting of a specific type of existing housing that is supported along its perimeter walls by a series of wood posts set on top of individual concrete pier pads. This type of construction is commonly referred to as a "post and pier" foundation. Post and pier houses are very susceptible to damage because they have an inadequate bracing system to resist earthquake forces below the first floor level. An effective bracing system can be provided by installing new "L" shaped partial perimeter foundations at each corner, properly connected to the existing first floor framing, or with a combination of new partial foundations and new braced cripple walls connecting the existing floor to the new cripple walls.

WHY EARTHQUAKES DAMAGE POST AND PIER HOUSES

In other sections of this manual you have learned about the importance of a complete load path to resist earthquake forces and how wood structural panel sheathing properly nailed to wall framing members with anchor bolts connecting the wall to a continuous foundation are used to provide that resistance. Two major weaknesses occur in the load path of houses supported by a post and pier foundation. One is the absence of sheathed walls below the first story exterior walls. The other is the absence of an adequate foundation under those perimeter walls.

A typical post and pier house uses wood posts spaced at 4 to 8 feet apart along the exterior perimeter walls to support the vertical loads from the floor and walls above. The top ends of these posts are typically toe-nailed to a wood girder that is part of the floor framing. The bottom ends of the posts are usually supported on individual foundation pads, often called pier blocks. These pier blocks are usually concrete, in a pyramid shape, with a square flat top surface where the post is supported. The bottom of the post is typically toe-nailed to a wood block embedded in the top of the pier block. The pier block may or may not have a larger square concrete pad below it embedded in t

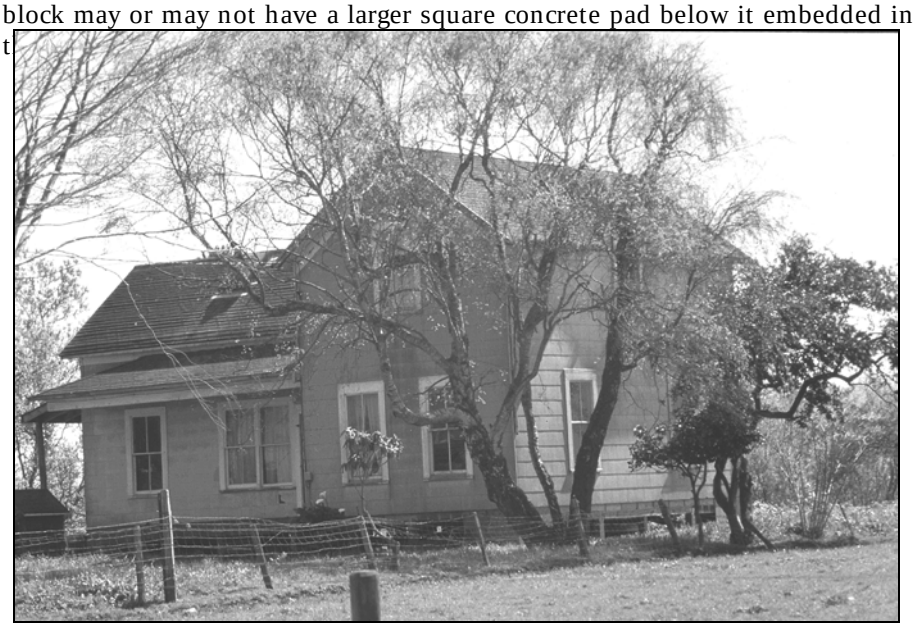

Fig.6. 1 Typical Existing Post & Pier Type House

The weakness in this system is that the posts and their top and bottom connections provide very little resistance to horizontal forces caused by an earthquake. Without a bracing system, the posts will topple over and the house will collapse to the ground.

Sometimes wood bracing installed in an "X" or "V" shaped pattern may interconnect the existing posts. These braces are typically nailed or bolted to the top and bottom of each post. This type of bracing may have been used as part of a repair of previous earthquake damage or as an attempt to provide some earthquake bracing. Although this type of bracing does add some resistance when compared to posts without any braces, it has too little strength to prevent damage and possible collapse at this level when subjected to strong earthquake shaking.
(Fig. 6.2)

Fig.6. 2 House with Braced Posts along Perimeter

The weakness in this braced system is primarily at the pier pad level. Here the connection between the bottom of the post and top of the pier must resist horizontal loads transmitted by the braces. If a traditional toe-nailed connection is all that is present, it will quickly be overwhelmed and the bottom of the post will slide off the top of the pier pad. This results in a loss of vertical support for the post and leads to a collapse similar to that for an unbraced post system.

Merely adding stronger connections at the bottom of the post such as a metal post base that is embedded in the pier pad and nailed or bolted to the post is also insufficient. The forces generated by the braces will then push on the pier pads and can cause them to slide or possibly overturn. Either one of these two effects will induce damage into the post and brace system causing it to degrade and possibly fail. A more reliable and stable retrofit method is needed for post and pier type foundations than is provided by this type of bracing.

NEW PRESCRIPTIVE RETROFIT METHOD

The prescriptive seismic retrofit standards contained in the Appendix of this manual are applicable to houses that have existing perimeter foundations and cripple walls. However, these standards require that a completely new continuous foundation be installed along all the exterior walls, or that a retrofit using a partial perimeter foundation must be designed by a licensed architect or engineer and be approved by the local building official. The prescriptive methods and details described in this section are consistent with the Uniform Code for Building Conservation (UCBC) and City of Los Angeles standards and use a partial perimeter foundation system to provide equivalent earthquake resistance below the first floor level. Permission to use this partial perimeter system without a specific design prepared by a licensed design professional must always be obtained from the local building official.

PARTIAL PERIMETER VS. CONTINUOUS FOUNDATION

Where a continuous foundation exists or is added, the primary retrofit elements used in the UCBC, are also parts of the partial perimeter system. They include:

- A foundation constructed with a concrete footing and either a poured concrete or grouted masonry stem wall.
- Foundation sill plates and sill bolts with plate washers.
- Sheathed cripple wall with connections between the wall and floor framing.

Note that a new cripple wall is not always necessary. A new foundation stem wall can be extended to the underside of the existing floor framing depending on how high the existing floor is above the surrounding exterior grade. Generally, if the floor is more than 3 feet above grade at any point, a cripple wall will be necessary.

Several additional retrofit elements are needed for a partial perimeter system that do not occur in the UCBC prescriptive standards. They include:

- New holdowns at the ends of new sheathed cripple walls.
- Straps to connect the existing floor framing beams and joists together and to connect them to the new partial foundations and cripple walls. These are load path elements needed to compensate for the use of a partial foundation system compared to a continuous foundation system

Certain elements of a partial perimeter retrofit must be stronger or larger than those prescribed in the UCBC. They include:

- Nails used to attach plywood to the cripple wall framing must be 10d common instead of 8d common.
- The minimum width of the new footing for a one-story house must be 15 inches rather than 12 inches.
- All foundation sill bolts must be 5/8-inch diameter instead of 1/2-inch, and their spacing is reduced from 6 or 4 feet on center to 2-'6" or 2'-0" on center.

HOW PARTIAL PERIMETER EQUALS CONTINUOUS FOUNDATION

The standard retrofit method for a house with an existing continuous foundation and cripple walls adds wood structural panels in sections along all the perimeter cripple walls and prescribes a minimum number of sill bolts connecting the foundation sill plate to the continuous foundation. Except for houses with existing brick or other unreinforced masonry foundations, the foundation itself should not need to be strengthened. The foundation's primary task is to resist the sliding forces transferred from the foundation sill bolts into the foundation, and to provide sliding resistance against the surrounding soil equal to or greater than the sum of all the sill bolt forces.

The bottom surface of the foundation resists these forces by friction between it and the ground. In addition, the vertical face of the foundation that is below the ground surface also participates in that resistance by pushing against the adjacent soil. Sliding friction and lateral bearing against the soil are the final link in the load path. The amount of surface area a foundation must provide to resist a specific amount of earthquake load is based on the characteristics of the soil that determine its sliding and lateral bearing resistance.

Chapter 18 of the Uniform Building Code provides numerical values for sliding and lateral bearing resistance of various soil types. The minimum depth, width and lengths of foundation used in the partial perimeter system are based on soils having the least resistance. Based on calculations, a continuous foundation is not required to provide the necessary resistance for average sized houses up to two stories in height. The minimum foundation consists of four separate, 15 inch wide "L" shaped footings, one at each of the building corners.

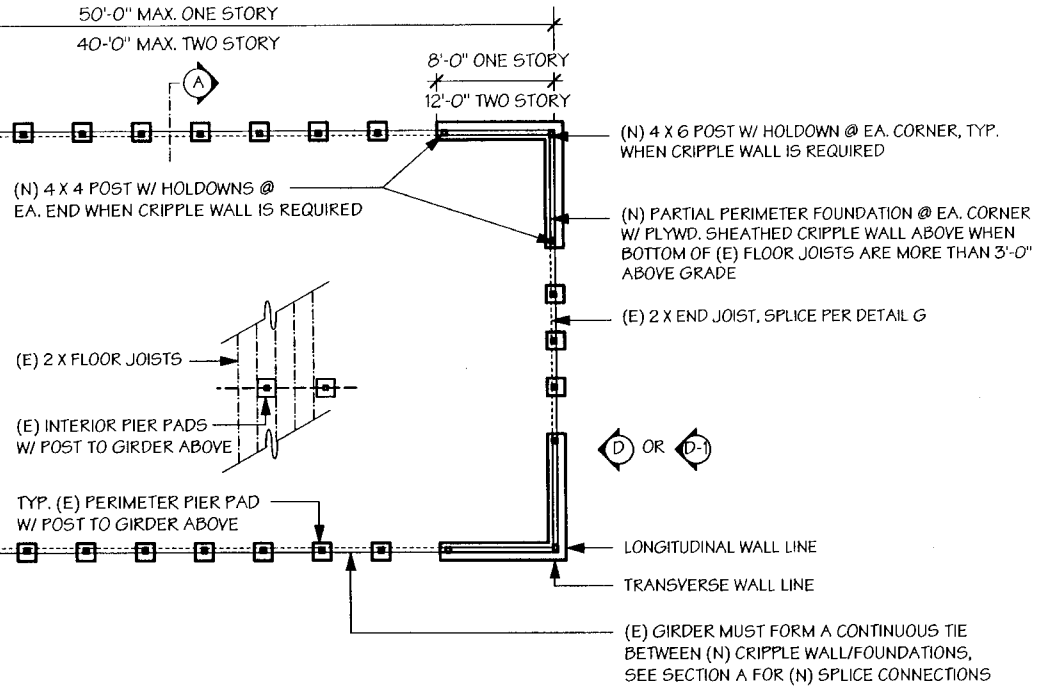

Fig. 6.3 Plan View of Partial Perimeter Foundation System

For a one-story house the length of each leg of the "L" must be 8'-0" and for a two story house each leg must be 12'-0". Four sill bolts are required along each leg of the one story house foundation and five bolts must be provided along each leg of the two-story house foundation to attach the new foundation sill plate.

When a post and pier house has its existing floor framing within 3 feet of the ground surface, constructing a new cripple wall above the new partial foundation should not be necessary. The existing floor joists and girders can be directly connected to the new foundation sill plate. However, for floor framing located higher than this, a new continuously sheathed cripple wall located above the entire length of each of the new "L" shaped foundations will be needed. The length of sheathing provided by the partial perimeter system is equivalent to the length provided by the multiple individual sheathed sections prescribed in the UCBC retrofit standards for a house with a continuous foundation and cripple wall.

MOISTURE EFFECTS ON WOOD MATERIALS

The partial perimeter system was specifically developed to address existing post and pier houses. It recognizes that post and pier type foundations are commonly found in coastal geographical locations where moisture content of the air and the ground are very high for much of the year. High moisture levels can have a very undesirable effect on wood framing members and will also decrease the strength of nailed or bolted connections in the wood.

One of the most important considerations when retrofitting any wood framed building is to examine all the existing wood members to be used in the load path and determine if they need to be replaced because of fungus infections, commonly called "dry rot", that destroy the wood fibers. Fungus infections flourish in wood when it remains wet and recur where it goes through cycles of wetting and drying. Such conditions are more likely to occur in damp climates, where post and pier construction is quite common, so particular attention must be paid to inspecting all existing wood members used in the retrofit of these houses. Unlike a house with a continuous perimeter foundation and cripple wall, where the underfloor space is fully enclosed and weather protected, the underfloor area of a partial perimeter foundation retrofit is open to the exterior along a substantial length of the perimeter.

Another aspect of wood exposed to damp climates is that the moisture content of wood does not remain stable. Instead, it undergoes cycles where it is very moist and then dries. As moisture content changes, wood fibers alternately swell and shrink and this changes the holding power of nails and the tightness of bolts in the wood. This condition is addressed in the Building Code by the use of a "*Wet Service Reduction Factor*" to reduce the strength of nailed and bolted connections. All the retrofit connections in the prescriptive partial perimeter system involving nails or bolts in wood have been adjusted to lower their strength to 75 percent of normal to account for this effect. This is the principal reason that 10d nails are needed to attach sheathing to cripple wall framing, and why 5/8-inch sill bolts are typically used.

The type of sheathing prescribed for use on the cripple walls of a partial perimeter system was chosen to address the moisture exposure issue. Exterior grade plywood is specified because it has a very high durability for exposure to moisture. Plywood rather than Oriented Strand Board, known as OSB, was selected because OSB has different moisture expansion characteristics that make it less desirable for use where its moisture content is expected to vary. For a more detailed discussion of sheathing materials see the *Shear Walls* section titled *How to Install Sheathing*.

HOLDOWN ANCHORS ARE NEEDED

The purpose of holdown anchors and their proper installation are discussed in the part of the manual titled *Connections Resisting Uplift Forces* and in the section on *Shear Walls.* Holdowns are generally needed either when a shear wall is very tall with respect to its length or when vertical loads from the weight of the building above, carried by the wall, are insufficient to offset the overturning force generated by the horizontal earthquake load the wall is resisting.

In the partial perimeter system, holdowns are used at each end of the new cripple walls. The reason holdowns are not required by the other prescriptive standards when retrofitting a house with a continuous foundation, is that the entire wall length can be engaged as part of the resistance to uplift. Using a partial perimeter system results in shorter wall lengths and less resistance.

The holdowns shown in Elevations D and E in the Appendix must provide at least 2,500 pounds resistance to earthquake loading. A variety of products can provide this capacity. The drawings depict one type of holdown that uses bolts through the cripple wall end posts and a bolt embedded in the new foundation. Similar holdowns using special screws instead of bolts may be used if the local building official approves them and they provide an equivalent minimum capacity. Other types of holdowns that use nails to connect to the post may also be used, but typically they require a post height of at least 24 inches. In addition, all nailed type holdowns have limitations on how close they can be placed to the corner of a concrete foundation and some may not be able to provide the minimum required capacity.

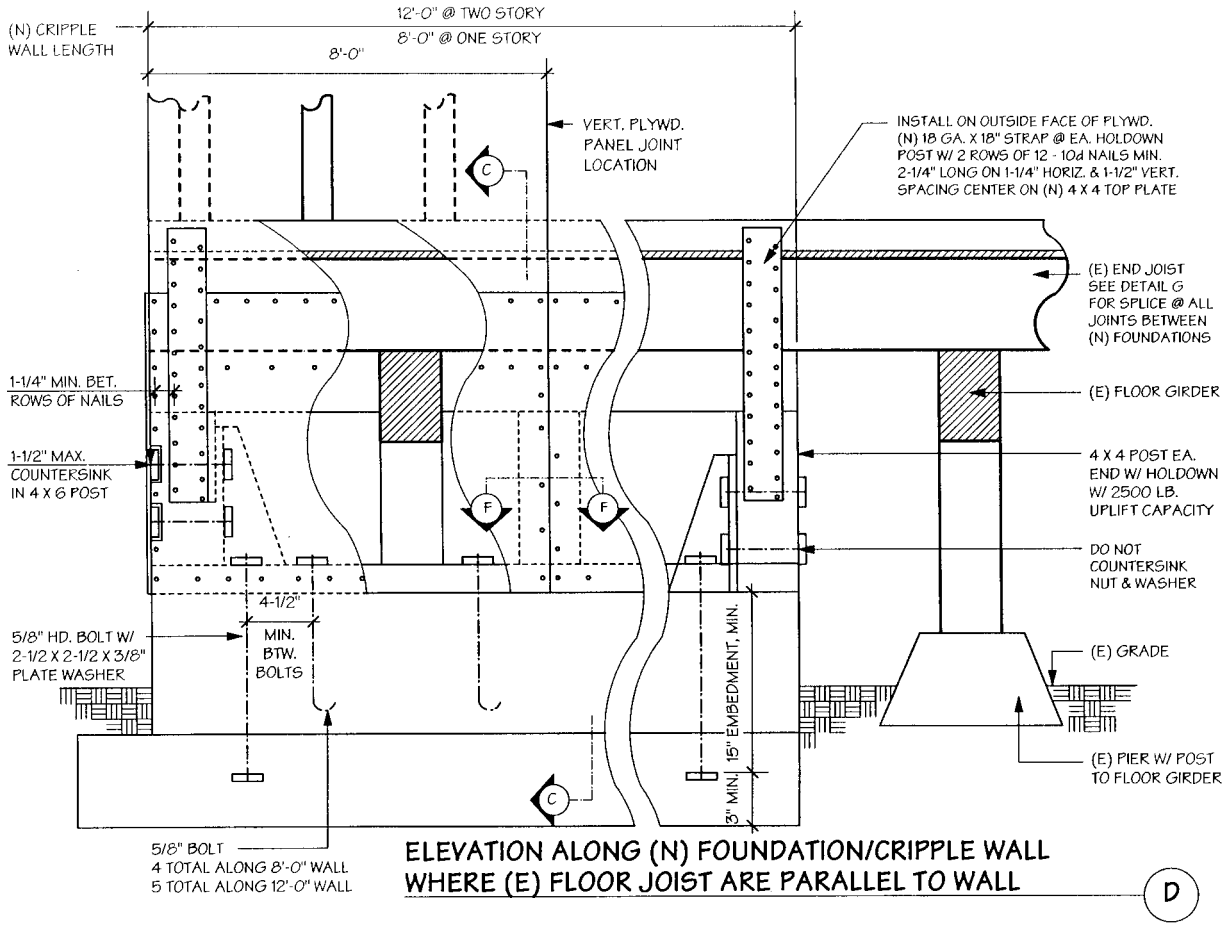

Fig. 6.4

In addition to the holdown anchor which connects the new posts at each end of the cripple wall to the foundation, a strap shown in Elevation D must be added at each end on the transverse wall sides to tie the new posts to the existing floor framing above. This is needed because the transverse walls are parallel to the floor joists and, therefore, do not carry enough dead load to adequately resist the uplift forces. The strap completes the load path between the holdown post and the floor framing so that the floor will not lift off the new cripple wall.

TRANSFERRING FORCES TO THE PARTIAL FOUNDATIONS

Another unique aspect of a partial perimeter system is that connections are required to transfer earthquake forces into the new foundations and cripple walls that are located only at each corner of the building. Essentially, each of the four new "L" shaped foundations are isolated from each other and therefore must be connected to the entire length of floor that lies between them to collect all of the forces in the existing floor system. With a continuous foundation, this kind of discontinuity does not exist, so none of the special ties and straps shown in the foundation/cripple wall elevations of the partial perimeter system are prescribed in other prescriptive standards.

Along the exterior perimeter of the floor, between the new corner foundations, where the ends of two pieces of an existing floor girder are spliced over a post, that splice must be reinforced with a new metal strap nailed or bolted to both pieces (Fig. 6.5). The details in the Appendix show both the bolted and nailed connection. The girder is used to drag forces along the edge of the floor into the new cripple wall or foundation at each end of the wall line and the strap provides this load path connection. Similarly, where existing floor joists are parallel to the exterior wall, a strap is needed at any joist splice occurring between the two corner foundations.

Fig.6. 5 New Metal Strap Reinforcement

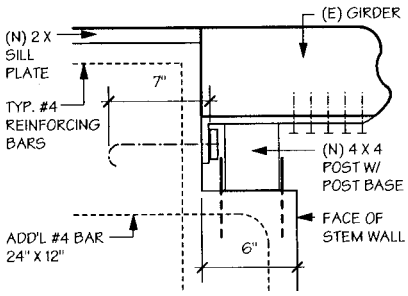

Fig 6.6 Girder Connection to New Foundation Stem Wall

A very important load path connection also must be provided at the end of each new partial cripple wall/foundation segment. The existing girder must be very securely connected to the new foundation or cripple wall to fully transfer the entire load along the edge of the floor that lies beyond the new partial foundation. When a new cripple wall is not needed, the Elevation E-1 view shows an anchor bolt embedded in the foundation stem wall secured to an "L" shaped 12 gage connector. The long leg of the connector is nailed to the girder (Fig. 6.6).

Where a new cripple wall is provided there are two options. The best solution is to use the existing girder as the top plate of the new cripple wall. If the girder extends as a single piece the full length of the new cripple wall, no connection is necessary. However, if the girder has an existing splice location within the length of the cripple wall, the typical girder splice shown in the Appendix details must be provided at that location.

If using the existing girder as the cripple wall top plate is not feasible, and it is cut flush with the end of the new cripple wall, a metal strap connecting the girder to the top plate of the new cripple wall must be provided as shown in Elevation E (Fig. 6.7). Because this connection will be subject to both tension and compression forces, it is very important that the girder end be carefully cut so that it will tightly fit against the new cripple wall or foundation. Also, to provide enough surface area to make this nailed splice connection and not interfere with the row of nailing along the top edge of the plywood, the new cripple wall top plate must be a minimum 4x4 member instead of using a typical double 2x4 top plate.

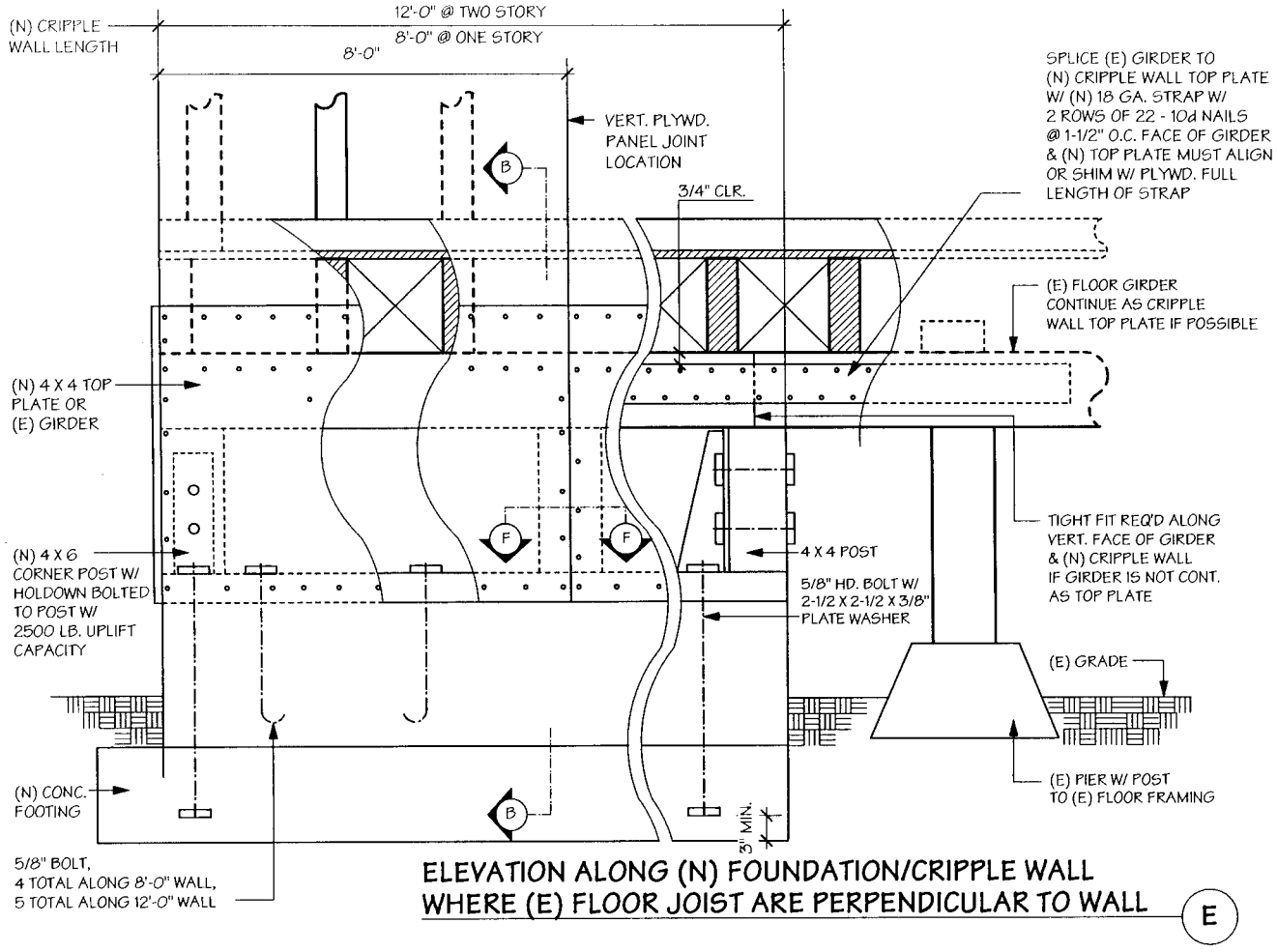

Fig. 6.7

One further consideration at this connection is that the vertical face of the girder and the new top plate must align because the strap should not be kinked or bent. A misalignment of 3/4 inch or less can be accommodated by installing plywood of the appropriate thickness on the face of the existing girder to make it flush with the new top plate. If this plywood shim is installed, the length of the 10d nails used in the strap must be increased to provide a minimum of 1-1/2 inches of penetration into the girder. Given the complexity of this connection, the use of the existing girder for the top plate of the new cripple wall is the preferred method.

Along the walls where the existing floor joists are parallel to the new foundation and cripple wall, the same concept of a continuous member applies. As shown in Elevation D, the end joist must be a single piece that extends the full length of the new foundation. This end joist must continue at least to the next perpendicular girder line beyond the end of the new foundation, where it may be spliced as shown in the Detail G (Fig.6.8).

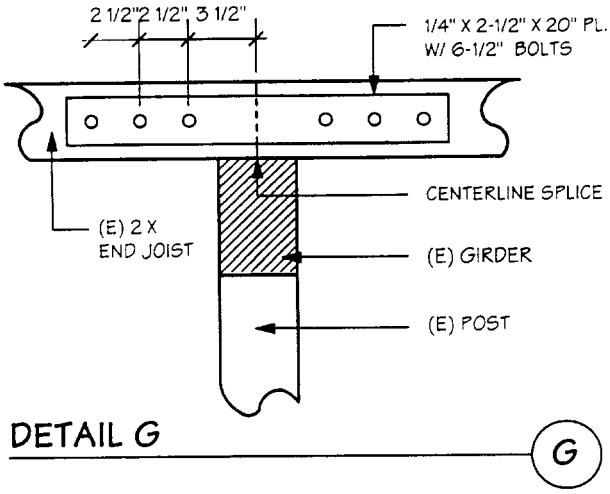

Fig. 6.8 Strap for Joist Splice

Also along this wall, another strap must be provided to tie together the new double 2x top plates of the cripple wall where they are interrupted by the existing girders framed over new support posts. This connection is shown in Section C (Fig. 6.9).

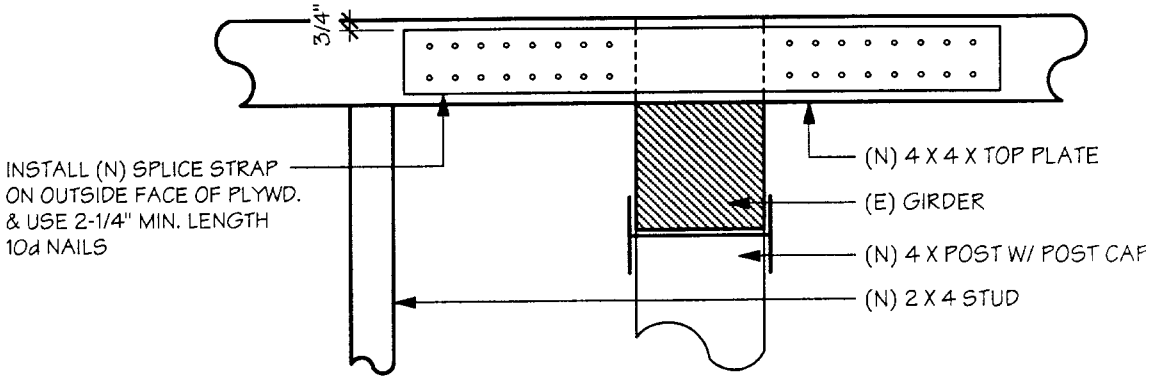

Fig. 6.9 Strap for Plate Splice

EVALUATING EXISTING CONDITIONS

The first step in any retrofit project is to carefully examine the existing building and its site to determine the extent of any unique conditions that exist for that building on its specific site. Some situations will preclude the use of a prescriptive method and instead will need the services of an experienced design professional. The condition of the existing wood framing, particularly along the perimeter walls must be checked for fungus or insect damage and all damaged wood must be replaced.

WHEN YOU NEED AN ARCHITECT AND ENGINEER

There are several important limitations on the use of the prescriptive partial perimeter system. Houses that are on a sloping site, where one side or end of the building is substantially higher above grade than other portions of the building, should not use this system. If the ground surface along the perimeter walls has a slope that exceeds 1 foot vertical in every 10 feet of horizontal distance, special structural considerations are necessary to accomplish an effective retrofit. Some sloping sites may need to be evaluated by a geotechnical engineer to establish the potential risk of landsliding or other forms of ground failure.

Houses that are over two stories in height or that exceed the maximum width and length dimensions shown on the prescriptive plan are too large to rely on prescriptive methods to provide adequate earthquake protection. The maximum height of new foundations are limited to 4 feet 6 inches measured from the bottom of the footing, and new cripple walls are also limited to a maximum of 4 feet in height. Retrofitting buildings where these limits are exceeded requires the professional services of a licensed architect or engineer.

The prescriptive method also assumes that the building is not located on soils that are subject to liquefaction during earthquake shaking or where highly plastic clay soil exceeds 25 feet in depth. Maps indicating locations of liquefiable soils are available in some cities and counties, and the local building departments will usually be aware of or have special foundation requirements in areas of highly plastic clay soils.

The prescriptive method should not be used for buildings located within 5 kilometers (approximately 3 miles) of a known active earthquake fault. Maps have been published by the International Conference of Building Officials for the entire State of California identifying these locations called “Near Source” areas. The 1997 Uniform Building Code requires that all buildings inside these areas be designed to resist larger forces than were used to develop the details used in the partial perimeter foundation system.

PARTIAL PERIMETER RETROFITS REQUIRE MORE ATTENTION TO DETAIL

Constructing a partial perimeter foundation system for a post and pier type house, involves much more work than installing new sheathing, foundation sill plate anchors, and miscellaneous framing anchors, which is typically all that is needed for houses with an existing continuous foundation and cripple walls. Prior to beginning to excavate for the new concrete footings, a system of shoring must be installed to adequately support the house where some of the existing posts and piers must be removed. Proper shoring is not only a major safety concern but it also serves to prevent damage to existing interior and exterior finishes like plaster that are intolerant of even small changes in the level of the supporting floor.

Preparing to pour the new concrete foundations involves accurately placing new anchor bolts and holdowns as well as installing the needed reinforcing steel. The formwork for the vertical stem wall must be strong enough to contain the concrete as its is poured and vibrated to form a solid mass without voids. If the optional masonry stem wall is used, proper knowledge of mixing and placing mortar are essential to its proper construction.

If the existing floor level is close enough to the ground, a cripple wall may not be needed on top of the new foundation wall, but in this case the top of the new foundation must be very carefully leveled before it is poured. All of the remaining work, including installing a new cripple wall if required, requires good carpentry skills to provide all of the additional nailed and bolted connections this system requires.

BUILDING INSPECTION REQUIREMENTS

The local building inspection authority will determine the exact number and types of inspections needed during the construction. Some jurisdictions may require a preconstruction inspection to determine if a prescriptive method is appropriate or if conditions exist that need the services of an architect or engineer. Typically inspections are performed prior to pouring any concrete or grouting of any masonry. In addition, a framing inspection will be needed during which the nailing of any cripple wall sheathing, the proper installation of plate washers on sill bolts and the installation of holdowns and other connections will be verified. A final inspection may also be necessary to determine that exterior weather protective surfaces have been properly installed over the new cripple walls.

SEISMIC RETROFITTING FLOOD-PRONE STRUCTURES

Some elevated residential structures will be located in both earthquake and flood hazard zones. For these buildings, seismic retrofit work must also be compatible with the latest standards for flood construction as contained in Part 59 of Title 44 of the Code of Federal Regulations.

FEMA's National Flood Insurance Program produces community maps that designate special flood hazard areas inundated by 100-year floods. The local community map repository should be consulted for complete information on base flood elevations before starting any new construction of partial or full perimeter foundation walls.

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7 NON-STRUCTURAL ELEMENTS

Edited by
Timothy P. McCormick, P.E.

NON-STRUCTURAL ELEMENTS

CHIMNEYS

The first nonstructural item to be considered is the chimney. There are two types of chimneys:

1. Masonry- reinforced or unreinforced
2. Stud Framed with metal flue.

Stud framed chimneys can be made with wood or metal studs.

Many older residences have chimneys constructed with unreinforced masonry such as brick or stone. Because these chimneys are not reinforced with steel and their mortar tends to deteriorate over time, they usually have little strength to resist earthquakes.

Even moderate earthquakes can cause extensive chimney damage. The portion of the chimney above the roofline is usually the first part to fail. Chimneys can break apart all the way to the firebox (Fig7-1). *Whether masonry chimneys are reinforced or braced to the roof structure, few construction methods have improved their performance during earthquakes* (Fig. 7.2).

Cracks in the chimney flue liner allow hot gases to leak into the wall or roof framing and start a fire. Therefore, a thorough inspection of the chimney after any significant earthquake will be necessary to identify any hidden or less obvious cracks. Video camera inspections and smoke tests may be required.

Question: *What can you do with "unreinforced" brick chimneys?*

Answer: There is one basic method for dealing with unreinforced brick chimneys:

REPLACE THE CHIMNEY!

Bracing of chimneys has been ineffective in preventing their failure during earthquakes. While replacement of the chimney is a costly solution, it is also the most effective technique to prevent damage (Fig. 7.3). In some cities, such as Los Angeles, full or partial replacements may by the only accepted method. Always check with the local building department for details and information.

Partial replacements remove all of the brick above the firebox. The chimney is then replaced with a reinforced masonry chimney or metal stud framed chimney with a metal flue. This method has often been used to repair earthquake damage. This less-expensive method removes most of the potential problem.

Fig. 7.1 Reinforced Chimney

Fig 7.2 Braced Chimney Failure

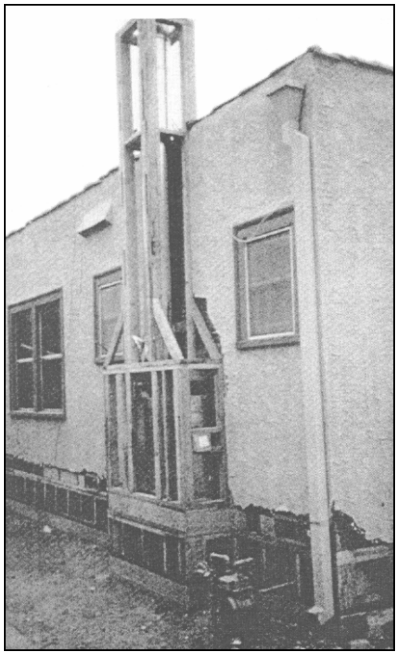
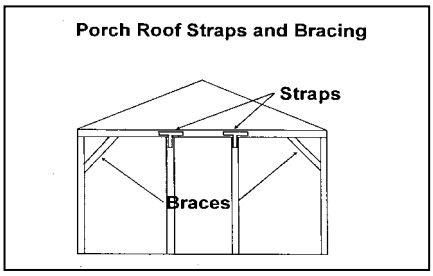


Fig. 7.3 Chimney Replacement

BUILDING APPENDAGES

Fig. 7. 4 Porch Roof Collapse.



All portions of the building, including those attached to the outside, experience horizontal earthquake forces. Most houses either have a porch, a deck, an exterior staircase, or other type of framing that is attached to the outside of the house. Few of the appendages are stiff or strong enough to resist the earthquake forces by themselves. Therefore, they need to be braced or adequately attached to the house to resist the earthquake forces.

If the appendage is not braced on its own or adequately attached to the house, it will collapse during an earthquake. This creates a falling hazard if the attachment is a roof. Since most of the attachments are located near the doors, it can also create a hazard for exiting the house if the attachment collapses.

Building appendages are usually connected to the house using nails, lag screws, braces or straps.

Nails are typically used to connect the existing house to the building framing for resisting gravity loads. However, nails may not be a sufficient method of attaching for horizontal type forces that also cause withdrawal (pull out).

Lag screws connect a roof or porch to the house in order to resist lateral earthquake forces. An architect or engineer may specify lag screws to attach the ledger to the framing of the house. The lag screw must be anchored into a stud for it to be effective. It will be necessary to drill pilot holes to locate the studs.

Straps are used when a simple attachment detail is not adequate to hold the porch or roof to the house. If the length of the appendage is more than its width, the architect or engineer may require straps at the ends of the appendage to resist the horizontal swaying of the appendage. This is similar to the requirement for holdowns for a shear wall.

Straps or brackets are used to prevent roof overhangs or elevated porches from becoming unstable if they sway too far during the earthquake. If the swaying is too great, the columns or posts supporting the outside ends will become unstable or detach. Many of the posts have little or no attachment to the roof or floor deck.

An architect or engineer may specify a strap or bracket to allow the post to move without separating from the roof or floor deck. This does not increase the strength of the post to resist earthquake forces. The only way to increase the strength of these posts is by adding diagonal braces. If the braces are not installed correctly, they will not be effective (Fig. 7.5).

VENEER

Another nonstructural item is veneer. Many houses have a layer of brick or stone veneer attached to the outside face of the exterior walls. Older houses may not have any attachment of the brick veneer to the wall except for a layer of mortar between the brick and the building paper.


Fig. 7.6 Fallen Brick Veneer

If the attachment of the veneer to the house framing is not adequate, the bricks may become dislodged during the earthquake causing the bricks to fall (Fig. 7.6).

New houses will have the veneer attached to the framing with wire ties embedded in the mortar joint. Even with wire ties in place, they may not be able to adequately restrain the bricks from falling out because they are:

- ☐ Too widely spaced and the bricks may fall out between the ties.
- ☐ Corroded or deteriorated.
- ☐ Attached to the wall with nails that are too small or short.
- ☐ Mortar may have deteriorated so that the tie will pull out of the mortar joint.

Mortar, especially older mortar, has very little strength for resisting earthquake forces, because mortar deteriorates year after year if not well maintained. When the spacing between the ties is too far, then the force on the ties as they try to restrain the bricks from falling out could exceed the strength of the tie.

Question: *What can you do to limit the hazards associated with brick or stone veneer?*

Answer: In order to limit the hazards associated with a brick or stone veneer, you should:

1. Add new anchors for the veneer.
2. Remove the veneer.
3. Do nothing unless the architect or engineer and owner decide that the veneer is a hazard.

The first option is adding additional restraints to the veneer to re-anchor the bricks or stone to the framing. The bracing must be spaced regularly in both horizontal and vertical directions. The restraints are intended only to prevent collapse of the entire section of the veneer. Since it is not practical to add restraints at every piece of veneer, adding the ties is not a guarantee that all of the veneer will remain intact during the earthquake. Some stones or bricks may become dislodged and fall during the earthquake shaking. The ties are intended only to prevent collapse of the entire section of the veneer.

The second option is the most effective: *remove the veneer.* If the bricks are removed, the area must be replaced with an exterior wall covering. The replacement should be weather tight and securely attached to the building framing.

The third option is to leave the veneer. The owner, engineer, or architect may decide that a section of veneer is not a problem.

GAS LINES

Fig. 7. 7 Automatic Shutoff Valve

Gas lines are a nonstructural item that can pose a serious risk if damaged during an earthquake. Fires often erupt following an earthquake because of broken gas lines. Any spark can ignite the leaking gas and cause a potentially violent explosion and fire. Installing automatic shutoff valves on the gas line can help prevent these catastrophic fires. These valves can be attached on either the inlet or outlet side of the gas meter for the building (Fig. 7.7).

The earthquake shaking causes the valve to stop the flow of gas. Most of the time, the leaking gas dissipates so that there is less chance of a large quantity of gas building up where a spark might develop. If there is a break in the line and a spark develops, the gas remaining in the air can still start a fire. The shutoff valve makes sure that there is no additional fuel to feed the fire so that it is less likely to get out of control.

In addition to the plumbing work required to put the valve on the gas line, the valve must be rigidly attached to the building. If the valve is not rigidly attached, someone could accidentally hit the valve, causing it to trip and shut off the gas for the house.

In some jurisdictions, shut-off valves may no longer be an option. The City of Los Angeles requires automatic shutoff valves to be installed when the cost of alterations to a house exceeds $10,000 or upon sale of the residence.

Currently, there are several manufacturers that make automatic shutoff valves. Any shutoff valve should be checked to verify that it meets the American Gas Association's standard. At the present time, this is the only standard available for shutoff valves.

Installation requirements for shutoff valves vary by manufacturer. Some manufacturers require that only approved contractors install the valves. Others allow anyone to install them.

Installing shut-off valves may require a plumbing permit. Check with the building department to find out their requirements for permits and approved manufacturers.

WATER HEATERS

One of the most common causes of fires associated with earthquakes is the rupture of gas lines when the water heater overturns. Water heaters are usually very tall, heavy (because they are filled with water) and narrow. These characteristics make them vulnerable to tipping over during an earthquake and starting a fire by breaking the attached gas or electrical line (Fig. 7.8).

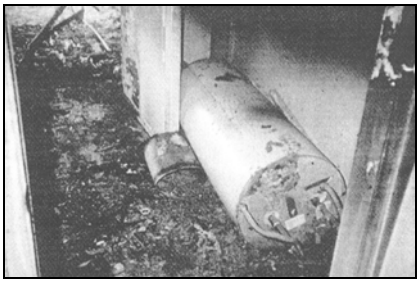


Fig. 7.8 Overturned Water Heater.

Water heaters are usually set on the floor, or on a pedestal. Until recently, codes did not require water heaters to be braced. The earthquake shaking produces lateral forces on the water heater at its center of gravity. The higher the center of gravity, the less force will be necessary for the water heater to overturn.

Question: *How can you prevent a water heater from overturning?*

Answer: To prevent the water heater from overturning:

1. Water heater must be braced at the top and the base.
2. Rigid connectors for the heater gas and water piping must be replaced with flexible connectors.

Because earthquake forces can make a water heater shake in all directions, a water heater must be braced at both the top and bottom. New water heaters are installed on platforms.

The top brace is used to prevent the water heater from tipping over. The bottom brace is necessary so that the base of the water heater will not move far enough to shift and slide out when the earth is shaking. The State of California has approved several typical details (Fig.7.9). There are other pre-packaged systems that have been approved (Fig.7-10).

Fig. 7.9 Braced Water Heater

In the typical details for the smaller water heaters, plumber's tape is commonly wrapped around the top and base area of the water heater. Struts are attached to the plumber's tape and then anchored into the wall framing using lag screws. EMT conduit works well as a strut. The ends can be flattened and drilled to attach the lag screw or bolt. Sample details are included in the Appendix.

Fig. 7.10 Pre-packaged System

For strapping of the water heaters, it is critical that:

- Plumber's tape or strap is wrapped all the way around the water heater.
- Lag screws are anchored into a stud. The stud must be one that is continuous from the sill plate to the top plate.
- Struts are used to brace the water heater to straight sections of walls. Plumber's tape only works in tension and has no strength to resist compression.
- Lastly, gas and water connectors must be replaced with flexible connectors and the flue should be braced. Flexible connections allow the water heater to move several inches without breaking.

During an earthquake, a braced water heater will still make some movements because of the slack and stretching of the straps. Even if the water heater moves only a small distance, the connectors may break if the connections into the water heater are rigid. The break can cause the water to flood the area or more seriously, cause a gas leak.

TANKS

A water heater is a type of water storage tank. Many houses have tanks to store liquids such as water or fuel. Natural gas is also stored in tanks. Usually these tanks are located outside the house and are raised up off of the ground. Like a water heater, these tanks are vulnerable to tipping over. Tanks that contain any type of fuel are a concern because if they tip over and spill their contents, they can ignite and cause a fire. The seismic retrofit of structural elements like elevated tanks or roof mounted equipment requires the expertise of an engineer or architect.

Question: *What are the most important considerations when dealing with elevated liquid storage tanks?*

Answer: The two important considerations for elevated liquid storage tanks are:

1. Brace the legs of the tank.
2. Provide a large enough concrete pad under the tank.

Bracing the legs of the tank is needed for the same reason as bracing the cripple wall of a house. If the tank sways too far during the earthquake, the legs can become unstable and the tank will fall over. Braces need to be provided in both directions on each side of the tank (Fig. 7.11).

The concrete foundation pad is needed below the legs of the tank to spread out the overturning force on the soil to prevent a soil failure that would cause the tank to tip over. A single pad under the entire tank is preferred.

When casting the pad footing, be sure to cast in anchor bolts for attaching the legs of the tank to the concrete. It is usually sufficient to place welded wire fabric in the footing to prevent cracking but be certain it remains in the center of the concrete during the pour.

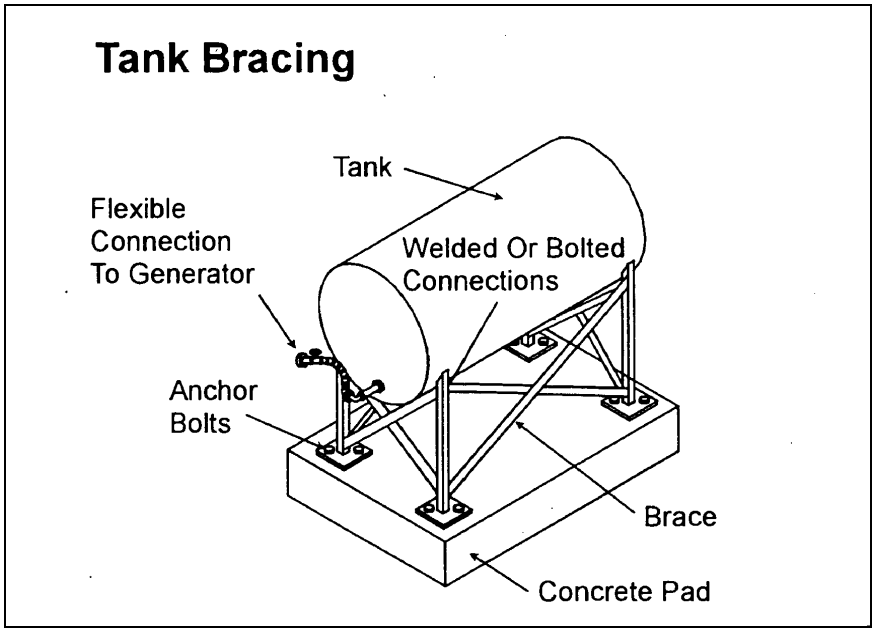


Fig.. 7. 11

OTHER TYPE OF NONSTRUCTURAL ELEMENTS

Houses contain many other items that can be a hazard to the occupants during an earthquake. The two most important types of hazards are:

- Items that may fall and block exits.

- Items that may fall and injure someone.

Question: *What are some examples of other non-structural elements?*

Answer: Some examples of other non-structural elements are:

1. Architectural items like windows, doors, and roofing.
2. Mechanical and electrical equipment like furnaces, roof or window mounted air conditioners, and chandeliers.
3. Furniture like book shelves, file cabinets, refrigerators, and wall hangings.

Fig. 7.12 Earthquake Damaged Air Conditioning Units

FEMA'S NONSTRUCTURAL MANUAL

It is easy to brace most nonstructural items and to prevent them from falling over during an earthquake. For more information about how to brace nonstructural items, the Federal Emergency Management Agency has a reference manual called:

"**Reducing the Risks of Nonstructural Damage: A Practical Approach**"

This guide is available through FEMA or at government bookstores. It has recently been updated to include findings from the Northridge Earthquake.

This nonstructural guide includes many standard details for bracing typical nonstructural items in a house or business. A homeowner or a contractor can install most of these techniques.

Some of the more complicated items have been designated as "*Engineering Required*". Bracing of these items are designed by an engineer because engineering expertise is needed to calculate the expected earthquake force generated by the item and the structural adequacy of the bracing that supports the item.

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8 SAFETY & LEGAL

Legal by George D. Calkins, Esq.

SAFETY ON THE JOB SITE

Safety on the job site is important for both you and your employees. Since most retrofit work is done while the house is occupied, safety is also a concern for the people living in the house. Here are some important safety tips for protecting all of the people that could come into contact with the project:

Wear Protective Clothing

Always use respirators whenever you're working in a crawl space, performing demolition work, drilling holes in wood or concrete, or using adhesive anchors like epoxy. Dust masks are not a substitute for a good respirator. Everyone should wear one. You need to check with the manufacturer of the respirator and the manufacturer of any chemicals used to be sure that the respirator is rated for your job. (Fig. 8.1)

Fig. 8.1 Proper Respirator

Hard hats should be worn at ALL times, particularly in tight crawl spaces where it is easy to bump into a floor joist or a protruding nail. Gloves should be worn when working with adhesives like epoxy to avoid skin damage.

Read and Follow MSDS

Material Safety Data Sheets (MSDS) provide essential information on the safe use of chemicals on a job site. OSHA requires that the MSDS sheets be available for any chemicals that are present at the job site. MSDS sheets can be obtained from the manufacturer of the chemical.

Rope Off Dangerous Areas

Use caution tape to keep people from straying into areas that may be dangerous. Put barriers up at all times, particularly during breaks and at the end of the day.

Do Not Disturb Asbestos

Houses built before 1980 may have asbestos insulation, particularly on heating ducts. If it likely your will disturb the asbestos, notify the owner to hire a qualified professional to remove it before your begin the retrofit work. Otherwise you may be liable for a very expensive clean-up and the contractor's state license board may discipline you (Fig. 8.2).

Fig. 8.2 Asbestos Heating Duct in Seismic Retrofit Work Area

PART 1 SEISMIC RETROFIT LEGAL PERSPECTIVES

By now you have reviewed materials in this manual relating to the specific means and methods for conducting residential seismic retrofit projects. You should be aware that there are important legal considerations relating to how seismic retrofits are conducted. Contractors should be aware of the following legal principles in their day-to-day pursuit of seismic retrofit projects.

In the Appendix of this manual is a form contract, which can be used as a reference in preparing a seismic retrofit contract. The form must be adapted to satisfy the unique requirements of each contractor's practice. It is intended to be only a resource for contractors, and not a final contract form.

EARTHQUAKE LEGAL BASICS

It makes sense to perform your construction assignments in the best manner possible in order to maintain and promote business. It makes obvious sense from a legal perspective as well, as you'll see hereafter in this presentation. Contractors are responsible for performing their construction work correctly: A contractor is legally responsible for any damages resulting from his/her negligent or substandard performance of his/her work. There has been a profound liability revolution in California during the last 20 years arising from poor construction of homes and condominiums. Owners and their insurance companies have proven that they will pursue contractors to collect their repair costs, if contractors perform their work contrary to the plans, specifications and established industry standards.

The basic contractor standard of care includes the obligation to understand and comply with applicable law, code provisions, regulations and industry standards of care as well as with the contract, plans and specifications applicable to your project. That duty includes the obligation to understand the impact of earthquake forces upon homes, as well as the design and construction techniques to appropriately address the impact of earthquake forces upon homes.

- **Duty To Understand Earthquake Forces**

A contractor is legally responsible to understand earthquake caused failures, including:

a. Base shear;

b. Earthquake overturning forces;

c. The lack of stability imposed by earthquake forces; and

d. Earthquake caused torsional rotation upon homes.

A contractor has the duty to properly perform his/her seismic retrofit work as to both the gravity and horizontal resisting systems in homes.

A contractor has an obligation to understand the following methods to minimize earthquake failures:

a. Shear walls;

b. Brace frame methods of construction; and

c. Rigid frame construction methods.

- **Agencies Have No Liability For Inspections**

Contrast this basic contractor duty to the lack of any government legal duty to properly inspect the building process. California Government Code Section 818.6 provides a basic immunity for local inspection agencies as follows:

> *A public entity is not liable for injury caused by its failure to make an inspection, or by reason of making an inadequate or n egligent inspection of any property, other than its property . . . for the purpose of determining whether the property complies with or violates any enactment or contains or constitutes a hazard to health or safety."* (Emphasis added.)

A frequent misconception of inexperienced contractors is to believe that government agencies are a source of responsibility concerning faulty construction. There is no claim for negligent inspection against public agencies or their employees. Public employees are equally liable with contractors for their negligent conduct, other than negligent inspection of construction (See California Government Code Section 820).

- **Prescriptive Standards**

There are two basic ways to design residential framing. The first method is to have an engineer or architect create the design. The second is to follow "conventional construction" provisions of the local building code. Similarly, there are the same two ways in which a seismic retrofit can be designed for light wood framed homes. An owner or contractor could hire an architect or engineer to design the retrofit. Many homes have complications that will require an engineer's retrofit design.

Often, what is needed for basic retrofit work are simple things like foundation bolting and plywood shear walls that don't necessarily require the expertise of an architect or engineer. Some communities offer classes for homeowners on how they can perform seismic retrofit work themselves. For these reasons, engineers and public agencies have developed general guidelines that can be followed to complete seismic retrofits. These guidelines are often called "prescriptive standards".

If a home satisfies certain clearly defined requirements, a contractor could use the prescriptive standards adopted by the relevant local agency instead of a plan specially prepared by an engineer or architect. ***HOWEVER, YOUR LOCAL BUILDING DEPARTMENT MAKES THAT DETERMINATION, and not you.***

Therefore, before starting a seismic retrofit project, a contractor is well advised to check with the local building department to see if it has adopted a seismic retrofit prescriptive standard. If such a standard exists, find out if the building department is satisfied that the specific home in question meets the requirements of the standard. When in doubt, consult the appropriate design professional and/or building official to make the decision as to whether a seismic retrofit can proceed by prescriptive standards, or whether a special plan by a design professional is needed.

It is important to remember that the goal of a seismic retrofit program is not an "earthquake proof home". Rather: the contractor is obviously targeting improved safety and performance of the home in an earthquake. It should never be stated that the home will be "earthquake proof", following a seismic retrofit program.

California law at Business and Professions Code Section 5537 does not prohibit any person from preparing construction plans, drawings or specifications for a single family home or multiple dwelling (no more than four dwelling units), of wood frame construction. That is, if the structure does not deviate from "substantial compliance" with conventional framing requirements for wood frame construction found in the most recent additional of Title 24 of the California Code of Regulations, as defined by the applicable building code of the local jurisdiction where the structure is located. Otherwise, the local jurisdiction will require preparation of specific plans, drawings, specifications and/or calculations for construction of the home and/or seismic retrofit, under direct supervision of a licensed architect or registered engineer.

- **Preconstruction Conferences**

Preconstruction conferences can be a useful tool to avoid legal difficulties. Under California Health and Safety Code Section 19872, an enforcement agency may require that a contractor participate in a preconstruction conference. This conference may be held prior to completion of plan checking concerning submitted plans and specifications or receiving a building permit. The purpose of the preconstruction conference is to review the plans to insure consistency of building code interpretations, and the adequacy and sufficiency of plan details. It is generally a useful practice for all concerned that local agencies require preconstruction conferences.

- **Statutes Of Limitations**

A contractor should understand the applicable "statutes of limitations" that apply to their liability exposure for seismic retrofit and other construction work. There is a three year basic statute of limitations that applies to claims for damage to real property arising from construction defects, following the time that an owner knew or should have known that his/her property was damaged as a result of the contractor's work. There is a two-year statute of limitations applicable to recovery of damages arising from errors in design of construction projects. There is a four-year statute of limitations for actions based upon breach of a construction contract, whereby a lawsuit must be brought within four years of damages arising from breach of the contract.

The law provides a four year statute of limitations for recovery for "patent", or obvious, defects in construction, pursuant to which an action must be brought within four years after "substantial completion" of the home that has the so-called "patent defect". Likewise, an owner has ten years within which to file an action for "latent", or undiscoverable, defects (without the aid

of an expert), arising from construction of the home following substantial completion.

- **Unlimited Exposure For Personal Injury**

It should be understood that a contractor has a virtually unlimited exposure period as to claims following completion of construction for personal injuries or death arising from faulty construction. If construction of a project causes injury or death, an action can be brought for personal injury more than ten years following substantial completion of the project, but within one year following the actual injury and/or death to the person.

There is an apartment building in Los Angeles that collapsed during the Northridge earthquake which had been substantially completed in the early 1970s. However, an action was permitted against the original developers, engineers and contractors who built the project, even though the project had been substantially completed almost 24 years before the events resulting in the 1994 collapse of the apartment building. The length of time during which a contractor is exposed to legal action should provide dramatic incentive for contractors to carefully monitor the quality of their work on any given project.

SHEAR WALLS

- **The "Code Minimum Syndrome"**

It should be understood that a contractor building a home to code requirements is sometimes not enough. The building code often follows changes in engineering knowledge and construction practice by a matter of months or years. Consequently, a local building code does not immediately track changes in the local community standards of care applicable to construction, as they evolve.

An example is the changing "values" allowed for drywall and stucco construction. Immediately after the 1994 earthquake, sound engineering practice required less strength value to be allocated for drywall and stucco shear wall construction than permitted under the then existing code. A contractor is responsible *to know, and follow*, the evolving standards of practice in all of the various areas of construction in which he/she is engaged, regardless of whether the local code has caught up.

- **Use Prescribed Wood And Shear Wall Dimensions**

It is important that a contractor use the type of wood specified in the plans for construction of framing, including shear walls. If the plans call for use of Douglas Fir, then a contractor should not use Hem Fir. If the plans call for one half inch or five ply plywood then that is the type of plywood that should be used by the contractor for the construction of shear walls.

By the same token, contractors should not change the shear wall length or locations from that specified in the plans without the approval of the engineer. Nor should a contractor change the nail sizes or spacing from that specified in the plans and specifications. Any such deviation, would constitute a violation of the standard of care established in the plans and specifications, and the local codes and established building practice, and would subject the contractor to liability exposure.

If a contractor cannot install the specified length of shear wall, then he/she should stop and call an engineer to design an appropriate resolution to the problem. If the contractor installs a shorter length of wall (or even splits the shear wall into two smaller components) the contractor will likely have reduced the shear capacity of the wall, and it may be too flexible and violate the applicable standard of care.

- **Coordination Is Important**

Coordination among the trades is essential to effective construction of a project. A contractor should not allow plumbing penetrations or electrical penetrations through shear walls without the approval of an engineer and/or the local building department. Contractors have a duty to be sure that the trades coordinate their work effectively as well as comply with the applicable plans, code and other standards of care

- **OSB**

Oriented strand board ("OSB") or other composite wood product panel may not be equivalent to plywood for a particular location (i.e., "wet" climates). While recent code changes have caused OSB to be deemed "equivalent" to plywood in most instances, OSB may not be appropriate in environments where there is substantial moisture in the air, such as locations near major bodies of water.

- **Plywood Strength**

The thickness and grade of plywood (as well as the size and number of fasteners securing the sheathing to the framing) will determine the strength of a plywood shear wall. It is prudent to always check with the local building department and/or engineer before substituting any sheathing material. If a contractor substitutes any material for the specified plywood, he/she may well be liable if that replacement material does not have the strength to resist earthquake forces possessed by the originally specified material.

- **Use Specified Nails**

A contractor should review the contract documents carefully and provide the proper nail size for each location specified in the plans. The contractor should not use nails other than those specified, without checking with an engineer and/or the local building department. If nails other than common nails are used, the connections will usually not satisfy strength requirements and will be considered to be below the applicable standard of care in many instances. The contractor should not use nails with clipped heads or apply coating to fasteners prior to installation, as those conditions can reduce the nail's ability to resist pull out.

Contractors should not substitute screws and staples for nails, unless an engineer has specified a screw or staple type fastener, or the substitution has been reviewed and approved by an engineer.

If the plans call for use of a ten-penny common nail, then contractor should put those in and not an eight-penny box nail. There is a substantial "strength" difference between ten-penny common and eight-penny box nails (63 lbs. vs. 94 lbs.). See the chart in the Appendix of this manual for different nail sizes.

- **Nailing Patterns**

If the contractor does not follow the nailing directions set forth in the plans, he/she will reduce the capacity of the wall and expose the contractor to future liability if the wall fails.

- **Economics Of Framing Affect Quality**

A note about the "economics" of framing: piecework is often the method of payment for those workers involved in the framing of homes. Such piecework payment could be dangerous. The "typical carpenter" will be more concerned with the speed of his/her work and that will often lead to loss of control of nailing and general framing quality. Likewise, poor training and supervision can substantially increase the risk of liability exposure to a contractor who pays his/her workers on a piecework basis. A good contractor must resist the economic temptation and tendency to downplay the quality of supervision, under such conditions of piecework compensation.

- **Nailing Patterns And The Liability Revolution**

It must be remembered that a substantial contributor to the liability revolution in California has been the failure of contractors to pay attention to the nailing pattern and size requirements set forth in the construction plans and local codes. Contractors are held to performing at least the code standard of care in their work, and must be sure that the framing pattern requirements stated in the local codes and the relevant project plans and specifications are followed in the construction of seismic retrofit projects.

A contractor should not substitute hardware from a manufacturer that has not been approved by the local building official and/or engineer.

CONNECTIONS

- **Holdowns**

A contractor should remember that for a hold down assembly to have the required strength, the stud bolt holds in the end stud or added post must not be oversized, and the stud bolts should not be counter sunk into the end stud or post. Also, the stud bolts should be fitted with washers and tightened. Lag screws should not be used as a substitute for through bolts, because the strength of lag screws may be less than the strength of through bolts. By engaging in such conduct, the contractor is again subjecting him/herself to liability exposure should the structure fail.

- **Beware Of Nonstandard Framing**

In evaluating a structure before undertaking a seismic retrofit, the contractor should contact an engineer when he/she sees a non-standard framing assembly in the existing structure, since standard details may not work in such a structure.

"Balloon framing" is one type of non-standard framing. Balloon framed structures were common in the Eastern United States between about 1850 until 1970. Some older buildings on the West Coast may have such balloon framing.

With balloon framing, the intermediate floor framing joists are face-nailed to the studs. When retrofitting balloon framed houses, the same principles for creating load paths apply. Blocking and connectors will be required at the roof and intermediate floor lines to connect the floor sheathing to the shear walls. For the connections to be effective, additional blocking must usually be added between the floor joists to provide shear transfer nailing at the top and bottom

of the sheathing. A contractor will be held to this heightened standard of framing care in such circumstances.

- **Proper Anchor Bolt Assembly**

When contractors are installing anchor bolts, washers and nuts are required on all anchors. Some building departments and engineers may require the use of square cut plate washers instead of round malleable plate washers. The contractor should make sure he/she knows which type of washer is required.

If the hole in the foundation sill is oversized, it will allow the sill to slide before pushing against the bolt. This small amount of unwanted movement during an earthquake can be enough to cause damage, usually in the form of slipping to the sill, and will thereby expose the contractor to liability. A contractor should never counter sink the washer and nut if the bolt is too short. The anchor bolt will not be effective, and a contractor will be liable for installing it incorrectly.

A contractor should likewise not drive lag screws into the framing with a hammer. He/she should always screw them into place. There are many types of anchor bolts and plate connections available. Before installing such materials, the contractor should check with the building department and project engineer to verify that the hardware used has been approved.

- **Protection From Fumes**

The contractor should always protect him/herself and his/her workers from fumes when using chemical epoxy anchors. The contractor should check with the manufacturer and the building department to find out, if an epoxy is appropriate for use and as to what precautions should be used, such as which respirator filters, protective clothing and ventilation will be needed. The contractor should also check the manufacturer's literature for information on the flammability of the epoxy.

FOUNDATIONS

- **Need Effective Communication**

The most significant legal consideration concerning the foundation areas of homes during seismic retrofit projects is the need for effective communication by contractors with their customers. Frequently contractors will observe conditions other than those directly relating to their scope of work on the seismic retrofit when they work under a home. They will see in many instances water leak conditions, plumbing leaks, drainage problems, termite infestations, deterioration and other conditions not specifically relating to their scope of work on a seismic retrofit. Contractors must communicate to the owner such observed different site conditions. Otherwise, he/she may assume legal responsibility for such conditions.

- **Prejob Walk Through**

This heightens the importance of the prejob walk through which should be conducted by contractors before they bid on seismic retrofit projects. Contractors who fail to communicate the conditions that they observe risk liability as well as risk inability to get paid for extra work arising from such conditions that should have been observed and communicated.

- **Identify Differing Site Conditions**

Leaking plumbing, leaks in roof areas, running surface water, as well as hidden wood rot and split bottom framing members must be called out and excluded from a contractor's work on a seismic retrofit. Such areas should also be specifically included in the contract to set the scene for more compensation as a change order. Such work would be outside of the traditional seismic retrofit scope of work.

The bottom line is that notification to the owner of existing conditions is essential for the contractor to avoid liability, and for the contractor to get paid for extra work arising from such observed conditions.

- **Legal Standards And Manufacturers' Specs**

It is important to understand that standards of care applicable to contractors can be partially defined by manufacturers' instructions for installation of their products. Manufacturers will often attempt to shift the risk of installation of their products to the contractor by prescribing specific methods for installation of such materials. Courts will sometimes use such manufacturer's specifications as a guide in measuring the legal responsibility of the contractor, along with the applicable contract provisions, code and the project plans.

- **Continuity Of Foundation**

Foundations in the vicinity of all shear walls should be continuous. The contractor should check with an engineer or building department to determine whether any lack of continuity in the foundation will affect the ability of the foundation to resist earthquake loads. It may be necessary to install new footings under the outside walls of the house and connect them to the existing foundation. Again, a contractor should contact an engineer where such may appear to be required.

- **Shoring**

A contractor must provide adequate shoring for temporary construction access before removing cripple stud walls, so that the home is not damaged during construction. Again, the contractor will be held to the standard of not weakening the structure while attempting to improve it.

- **Concrete Quality And Owner Consultation**

The strength of the concrete in the foundation can also deteriorate due to reaction of the soil with the concrete over time. This usually can be seen if the surface of the concrete is rough and appears to have been “eaten away”. An engineer should check this before the contractor installs a retrofit.

It will be the obligation of the contractor to make certain that an engineer is consulted, or at least that the owner should be informed of the need for such consultation, and the contractor should document this communication to the owner. Frequently a contractor will encounter the desire of an owner to restrict his/her budget and to lower the cost of construction.

NONSTRUCTURAL ELEMENTS

- **Care In Specification Of Bracing**

The contractor should not take responsibility for recommending bracing that could be damaged during an earthquake. If an engineer or an architect specifies bracing, the contractor should make sure that his/her contract says that he/she is not responsible for future damage arising from such construction.

A contractor should not take responsibility for specifying the straps or braces for such things as carport covers and/or water heaters. An engineer should be consulted to design such installations. Likewise, a contractor should not take on potential liability by recommending any particular type of veneer construction. That should be the responsibility of an engineer and/or architect.

A contractor should not use a system or detail in his/her construction activities that has not been approved by the relevant local building official. A contractor should always check with the local building department to be sure as to whether a particular system or detail has been so approved. This is particularly applicable to bracing of water or propane tanks, water heaters, chimneys, and the like.

End of Part 1

PART 2 A CONTRACTOR'S LEGAL RELATIONSHIP WITH THE CUSTOMER

Seismic retrofit contractors need to understand certain basic legal concepts applicable to their relationship with their customers. First and foremost is the need for a contractor to be an expert at communications with his/her customer, subcontractors, the applicable local building department, his/her workers, the architect and/or engineer, and the suppliers who provide material for any seismic retrofit project.

The key is for the contractor to have an ability to talk with people and to coordinate his/her activities to maximize his/her legal position on any project. Also, the contractor should keep accurate records of what he/she is doing on any given project including what is in his/her contract, as well as what he/she has to do to perform that contract. All contractors should be aware of the standards applicable to his/her work on any given project including:

a. The contract and the specifications designed for the project;

b. The plans and other specific details applicable to the contractor's work on the project;

c. The applicable building code;

d. Applicable trade association standards and manufacturer's installation instructions;

d. Standards of care applicable to construction of such projects in the location of each project worked on by the contractor.

UNDERSTANDING THE OWNER'S CONCERNS

A contractor should be aware of the various concerns (sometimes conflicting) of the homeowner in regards to seismic retrofit work. Going into each job fully knowledgeable and prepared will help avoid any misunderstandings with clients. Owners will be seeking advice on hiring contractors from a number of sources, including local consumer organizations and the Contractor's State License Board. Each contractor should know what the owners will be expecting. He/she should also know what he/she must do to clearly set forth the scope of the work that he/she is performing, as well as the limitations on a contractor's responsibilities and liabilities. The contract documentation, particularly the scope of work, is essential, as we will see shortly.

- **Money Limitations**

Most owners do not have a lot of money to perform retrofits. Some owners will want to retrofit because it will make them feel safer. Others will be retrofitting to meet some obligation, like a homeowner who wants to sell a house for a better price, or to get earthquake insurance.

Whatever the reason, most homeowners will not want to spend any more than is necessary to get the job done. Most owners will be getting several bids for the retrofit work. A contractor should make a fair and reasonable bid based on a clear contract. The Appendix contains a suggested form contract that

could be used as a basis for developing your own form contract. A contractor should not try to low-ball a bid hoping to "make it up with change orders". This is frankly a dangerous fantasy. The owner may simply not have the money for change orders.

- **Disruption To The Occupants**

Most retrofit work will require some disruption to the occupants of the building, including noise, loss of services, and/or inconvenience.

A contractor should work out an arrangement in advance with the owner to let him know when the work may be disruptive. Owners do not like to suddenly find out that their water or power has been temporarily turned off.

- **Schedule**

The owner wants to know when his/her house will be back to normal. A contractor should clearly state the projected timeline for completion, and make sure that the owner is aware of it. Also, the contractor should let the owner know about anything that may cause a delay in the schedule.

- **Background Information**

Many homeowners will ask for information about their contractor's experience. A contractor should be ready to provide references from previous jobs, proof of bonding and insurance, as well as his/her contractor's license number.

LIMITING A CONTRACTOR'S LIABILITY

One way a contractor can protect him/herself is to have the necessary paperwork that explains what he/she will do and has done. Today many people seem to be very anxious to pursue litigation if anything goes wrong. One of the most important responsibilities of the contractor is to protect him/herself from potential lawsuits. One way that a contractor can do this is to have the necessary paperwork that explains what he/she has done.

- **Necessary Documentation For Each Project**

❑ **Liability Insurance**

The contractor should have an appropriate comprehensive general liability insurance policy, or similar form of insurance. This should provide coverage to the contractor, should he/she incur negligence and construction defect liability as to work that he/she has performed for his/her customer. The contractor should attempt to obtain an additional insured endorsement from each of the subcontractors, adding him/her as an additional insured. Also, to the extent possible, the contractor should make sure that each job site that he/she works on is specifically identified on his/her liability insurance. This will provide specific recognition by the contractor's carrier that it is providing liability coverage for each of the projects that a contractor is working on.

❑ **Project File and Documentation**

A contractor should be sure that he/she has an appropriate file including the contract, plans, correspondence and other relevant materials. He/she should make sure that he/she keeps his/her file and notes as to any unusual job

circumstances so that his/her work is thoroughly documented. The better the contractor keeps his/her file, the more likely that he/she will be able to cope with any liability issues that come up after his/her work is completed.

❑ Employee and Subcontractor Screens

The contractor should make sure that he/she carefully screens his/her employees and subcontractors. He/she should be satisfied that they have the capability to consistently perform the project in a good workmanlike manner, which they have been hired to complete.

❑ Applicable Local Codes

The contractor should be sure that he/she understands the latest applicable code and code interpretations that apply to the work in the specific jurisdiction where he/she is working.

❑ Preconstruction Walk Through

It is very important that the contractor do a walk through of the project. If the drawings are available, he/she should review them before the walk through. Before bidding, each contractor must walk through the project area and be thoroughly familiar with the existing conditions. This is essential for the senior most executive with the retrofit company to be aware of these circumstances.

If an engineer designs the plans, he/she should be consulted by the contractor if there any questions about the design or existing conditions. It should be remembered that most engineers are not contractors and don't always know what can be done from a practical standpoint on a retrofit project. The contractor should use the walk through as an opportunity to identify any obvious problems with the proposed work.

A contractor should not wait until he/she starts work and hope for a change order. The engineer will say that he/she has seen the conditions before starting. it is important to raise questions regarding existing conditions before starting work.

• THE IMPORTANCE OF A CLEAR WRITTEN CONTRACT

The contractor should have a written contract stating exactly what work will be done and how much the owner will pay for the work. Without a clear contract it will be difficult to get paid extra for work that exceeds the scope of the original agreement.

❑ Scope Of Work Is Important

The most important part of the contract is the scope of work provision. The scope of work provision should carefully state what work the contractor is performing, including reference to plans, specifications and applicable codes, where appropriate. The scope of work section of the contract should just as clearly state what is not in the contract; that is, what work is excluded and will not be performed by the contractor. This provision particularly depends upon the effectiveness of the prejob walk through by the contractor, and should include all items which are noted, and which are not to be performed by the contractor. In many instances this is the most important part of the contract, i.e the exclusions.

❑ Termination Options

The contract should also have carefully stated termination provisions. The contract should state when, and under what circumstances, the contractor may terminate his/her contract; that is for failure to pay progress payments, undue interruption and interference by the owner, and similar such circumstances.

❑ Exculpatory Provisions

The contract should also have exculpatory provisions relieving the contractor from any liability for existing conditions on the site, which are not the specific focuses of the contract. Such conditions may increase the scope of required work on the part of the owner, once the contractor has identified them.

❑ Liability Revolution

The contractor should be aware that there has been an expansion of construction defect claims against contractors and developers in the last 20 years. These claims touch upon such things as inadequate framing, inadequate plumbing, poor soils work, inadequate roof work and other workmanship claims, including those claims involving window installation, waterproofing and the like. The contract should have provisions citing the potential for these conditions and that the owner understands that the contractor is not accepting responsibility for such existing conditions which are uncovered during the course of performing the actual work under the contract.

❑ Additional Work

The contractor should make it clear that if there are any such unforeseen circumstances, which may indeed increase the scope of work on the project, that the owner agrees to pay for any such additional work, which is requested by the owner, and which is necessitated by hidden preexisting.

All participants in the construction industry have been increasingly protecting themselves with appropriate insurance and contractual language to help limit, cover or control the scope of their liability under their construction contract. Retrofit work of this nature, often will involve conditions of poor previous or original construction and other circumstances for which the contractor does not want to be responsible. *He/she should make that clear in his/her contract!*

❑ Get A Lawyer's Help With Your Contract

It is a good idea to contact an attorney who can prepare a standard form contract for use. The contractor should work with the attorney to adapt the contract to each job and its specific requirements.

❑ Key Contract Provisions

The sample contract form in the appendix may be a starting point. The following is a listing of the key provisions that a retrofit contract should contain:

1. Scope of work, including plans and codes.

2. Time to complete project.

3. Price of work and payment schedule.
4. Subcontractor's names.
5. What's in and what's out of the contract, in terms of scope of work.
6. Change order provisions.
7. Termination provision.

- **GOOD SET OF PLANS**

The contract should make reference to and incorporate the set of plans that will be used on the project. All of the work (whether working from an engineer's design or using a prescriptive standard) must have a workable set of drawings showing the details of the building project with all retrofit work that is to be done under the contract.

If an engineer or architect will not be involved, the contractor will be responsible for obtaining a set of drawings. He/she can hire an engineer or prepare drawings him/herself, only if they comply with an approved prescriptive standard. If the contractor does prepare drawings, they obviously should be checked with the Building Department to make sure they comply with the existing prescriptive standards. Otherwise, an architect and/or engineer should always prepare an appropriate set of plans.

The plans should make clear that they are tied to and coordinated with the contract, and the contract should say so. The plans should be directed to specific code provisions where appropriate. The project plans should include by name, the design professionals who are responsible for them. The contractor should not take responsibility for the plans and, should, where possible, state in the contract that the design is separate and from the contractor's responsibility.

If there is no set of plans, then the contractor has no basis for bidding the job, and the owner probably doesn't know when the job will be completed for final payment. If there are any changes to the design that are needed because of changes in scope, those should be shown on amended drawings.

- **BUILDING PERMIT**

All retrofit work requires a building permit. Even if the work is done voluntarily, using a prescriptive standard, a building permit is necessary. Check with the building department before starting to make sure that all necessary permits are obtained.

KEEPING TRACK OF THE WORK

In addition to the above-referenced "starting documents" the contractor must keep records of everything that happens during work on the project. Following are some of the ways to document the course of the work,during the project:

- **Notification Of Existing Conditions**

The contractor is only responsible for retrofit work that he/she actually does. There may be other conditions in the home, as discussed above, that need repair, or are not up to current standard. The contractor is not a building inspector looking for problems. These areas should be specifically excluded from the work scope or included in writing by change order for more pay.

Normally, building departments will not require that the entire building be brought up to current code requirements. If there are obvious problems, such as damage or decay to the structural members, the contractor should point them out to the owner (especially if they present a potential danger). If the owner decides to do something about the condition, then the contractor should get a change order. Without that, the contractor should make clear that such conditions are outside the scope of work of the contract, as discussed above.

- **Change Orders**

The contractor should document in writing any changes that are requested by the owner or engineer. This will be important, if there is a question about any differences between the as built condition and the drawings. This is also obviously important for the contractor to be able to obtain payment for any extra work he/she performs. The contractor should be sure that he/she gives notice of a potential claim for any additional work to the owner, and that the contract supports the contractor's right to a change order, including increasing his/her compensation and extending the time allotted for completing the work.

- **Inspections**

Having a building permit almost always requires some items to be checked by the building inspector. The building inspector generally verifies (without liability on his/her part) that the work is being done according to the approved plans and according to the building code.

Inspections should be viewed as opportunities to learn what is being done wrong before the work is rejected, the building fails or a claim is made. If there are any errors that are not caught by the inspector, then the contractor alone is responsible for the consequences; as the inspector is protected by immunities built into the law. (See discussion above.)

Even if the inspection misses something, or passes it off as good enough, that does not necessarily keep the contractor from being sued if something does go wrong later. The contractor should keep a record of each day that the inspector is on the job and what he/she checks and what his/her comments were.

If an engineer designs the job, the engineer may also come out to the site and inspect the work. The contractor should also keep track of this information and use it as an opportunity to discuss any unusual conditions.

If the contractor finds a problem and doesn't show it to the engineer, then the contractor will be responsible for the consequences. It is in the basis best legal interest of the contractor to communicate problems in construction to the owner and his/her design professionals.

- **Photographs**

A picture is often "worth a thousand words". The contractor should take pictures of existing conditions before starting work. If there is ever a question about what a building looked like before retrofitting (or just to prove how bad the existing construction was), the contractor will have evidence to support his/her position regarding a potential change order.

Also, the contractor should take pictures of each part of the job as it is completed. The contractor can use that photographic material to prove that the work was completed and to show to potential future clients.

GETTING HELP

No one likes to admit that they do not know it all. Part of the contractor's responsibility, as a professional, is to know when he/she needs assistance from someone else. The contractor usually obtains during construction information about various conditions that should alert the contractor to get advice from an

engineer or other professional, or at least the owner or relevant building department.

A WORD ABOUT WARRANTIES

There are no earthquake proof buildings. Even well designed buildings may have some damage during an earthquake. Seismic retrofit of wood frame buildings does not guarantee that the building won't be damaged during the next earthquake.

Indeed, the contractor should understand that earthquake repairs are made in order to effectuate safety measures. Sound engineering practice and code compliance should produce a building that will protect occupants in a life/safety situation, but the building and its contents may still be substantially damaged.

The contractor should also be aware that engineering practice is constantly evolving regarding earthquake safety issues. The work that the contractor does now may be obsolete in a few years when another earthquake occurs.

The contractor should not mislead the owner to believe that the house will be undamaged during an earthquake. The contractor should explain to the owner that seismic retrofits try to prevent severe damage to the homes by fixing obvious weaknesses.

If the work is done carefully and correctly, however, the contractor can tell the owner that the house should have less damage than a similar house that has not been retrofitted. Older houses may have many other problems that are not corrected by the retrofit (and aren't apparent at the time of the work). The contractor does not want to take responsibility for the entire building, particularly if the contractor only retrofitted a small part of the building, such as the cripple walls.

A typical warranty will be one year for workmanship, but will also be ten years (under law . . . even without an agreement) for latent defects. Whether the contractor gives a warranty or not, he/she is exposed to liability for up to ten years for property damage resulting from latent defects and four years for patent defects, as defined above. Also, the contractor is responsible for three years, at a minimum, for property damage resulting from negligent workmanship on the contractor's
part, after the time the owner knew, or should have known, of any damage resulting from a contractor's workmanship.

WHEN SHOULD A CONTRACTOR QUIT A PROJECT

The contractor should only quit a project when he/she has a right to quit. The contractor has a right to quit when he/she recommends engineer's input on safety issues and the owner refuses to obtain an engineer's input on the basis of cost. The contractor should put language in his/her contract to give him a right to quit, upon a fundamental unresolvable disagreement with the owner.

For a more thorough discussion of legal requirements, see the Supplement *titled "Legal Aspects of Construction and Administration"* in the Appendix.

GLOSSAR

GLOSSARY OF ENGINEERING TERMS

Engineering terms often used in discussions of seismic design and retrofit.

Acceleration -The rate of change (increase or decrease) in velocity. As seismic waves travel through the earth, the ground moves backward and forward changing its velocity; acceleration is related to velocity and displacement.

Anchor Bolt - A cast-in place bolt used to connect the foundation sill to the foundation.

Adhesive Anchor – An assembly consisting of a threaded rod, washer, nut, and chemical adhesive for connections to existing concrete or brick elements. Chemical adhesives may be epoxy, esters or acrylics.

Compression -When a wood member resists a pushing force along its axis on each end towards its center, typical of columns, posts and holdown studs.

Connection - A point at which different structural members are joined to each other or to the ground.

Cripple Wall - A wood stud wall less than full story height; typically between the first floor and foundation wall.

Damage - Any economic loss or destruction caused by earthquakes.

Deflection - horizontal or vertical movement or displacement (See DRIFT)

Diaphragm - A horizontal or nearly horizontal structural element designed to transmit horizontal or earthquake forces to the vertical elements of the seismic resisting system.

Drift - Lateral deflection of a building caused by lateral forces.

Earthquake- A sudden motion or vibration in the earth caused by the abrupt release of energy in the earth's lithosphere. The wave motion may range from violent at some locations to imperceptible at others.

Elastic - Capable of recovering size and shape after deformation.

Epoxy Anchor – a type of adhesive anchor using epoxy as the chemical adhesive; SEE Adhesive Anchors

Expansion Anchor - An assembly containing a bolt, washer, and nut for connecting to existing concrete elements. The base of the bolt is designed to expand when properly set, wedging the bolt in a predrilled hole.

Fault - A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Floor Girder - A beam that supports floor joists.

Foundation – As commonly used in residential construction, refers to the masonry or concrete perimeter wall or slabs and footings that a house sits on. The more accurate definition is the ground (rock or soil) that supports these systems.

Holdown - An element connected at the ends of the framing of a wall to prevent uplift of the wall.

Horizontal - A direction parallel to the ground (sideways).

Inertia Force - A force generated by an object as it shakes. The force acts in the opposite direction of the shaking and is related to the weight of the object and its acceleration.

Intensity - The apparent effect that an earthquake produces at a given location. In the United States, intensity is frequently measured by the Modified Mercalli Index (MMI).

Joist –horizontal wood members that support floors or ceilings.

Lateral (Horizontal) Force Resisting System - The part of the structural system that has been considered in the design to provide the required resistance to the prescribed seismic forces: IE shear walls, braced or rigid frames, floor and roof diaphragms and foundations.

Lateral Load (Force) - Side-to-side force(s) acting on a structure.

Load (Dead) - The gravity load created by the weight of all permanent structural and nonstructural building components such as walls, floors, roofs, and the operating weight of fixed service equipment.

Load (Live) - Moving or movable external loading on a structure. It includes the weight of people, furnishings, equipment, and other things not related to the structure. It does not include wind load, earthquake load, or dead load.

Magnitude, Earthquake - A measurement of the relative strength of the earthquake shaking. Magnitude is often reported using the Richter Scale.

Mass - A quantity or aggregate of matter. It is the property of a body that is a measure of its inertia taken as a measure of the amount of material it contains that causes a body to have weight.

Mudsill / Foundation Sill / Sill Plate - The wood member that attaches to the foundation.

Perimeter - The outer sides of a building.

Pier - A masonry or concrete column used as a beam support structure.

Pier Block - A pre-formed block of concrete used as a footing to support a post.

Post / Column - A load-bearing vertical member.

Racking - A movement that can distort a framework.

Rafter - The roof support members.

Resonance - The amplification of a vibratory movement occurring when the rhythm of an impulse or periodic stimulus coincides with the rhythm of the oscillation (period). For example, when a child on a swing is pushed with the natural frequency of a swing or when an earthquake shakes a building at its own natural frequency.

Richter Scale - Named after its creator, the American seismologist Charles R. Richter, a logarithmic scale expressing the magnitude of a seismic (earthquake) disturbance in terms of its dissipated energy.

Seismic - Of, subject to, or caused by an earthquake or an earth vibration.

Seismic Forces - The assumed forces prescribed in the Uniform Building Code related to the response of the building to earthquake motions to be used in the design of a building and its components.

Seismic Hazard - Any physical phenomenon such as ground shaking or ground failure associated with an earthquake that may produce adverse effects on human activities.

Seismic Risk - The probability that social or economic consequences of an earthquake will equal or exceed specified values at a site, at several sites, or in an area during a specified exposure time.

Seismic Strengthening - Adding additional bracing, anchoring, or improvement to a structure after the original construction is completed.

Shear - A deformation in which parallel planes slide relative to each other and remain parallel.

Shear Wall - A wall, typically made of wood studs and wood structural panels, built to resist lateral forces from wind or earthquake, acting in the direction of the wall.

Sheathing - The material covering the surface of a wall.

Stiffness - Resistance to deformation of a structural element or system.

Strength - The capability of a material or structural member to resist or withstand applied forces.

Stud - The vertical members in the walls.

Tension - When a connector or wood member resists a pulling force along its axis such as a suspended ceiling or a holdown stud under uplift.

Top Plate - The horizontal members that fasten at the top of the studs and support the rafters or joists.

Torque - The action or force that tends to produce rotation. In a sense, it is the product of a force and a lever arm as in the action of a wrench twisting a bolt. IE 50 ft-lbs. is a force of 50 lbs. applied at the end of a 1 foot wrench to tighten a bolt.

Uplift - Force(s) acting to lift a structure or an element.

Velocity - the measure of speed and direction of an object

Vertical - A direction perpendicular to the ground.

Wall, Bearing - A wall providing support for vertical loads; it may be exterior or interior.

Wall, Nonbearing - A wall that does not provide support for vertical loads other than its own weight as permitted by the building code. It may be exterior or interior.

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APPENDIX

Appendix A CITY OF LOS ANGELES PRESCRIPTIVE STANDARD

CHAPTER 92

VOLUNTARY EARTHQUAKE HAZARD REDUCTION IN EXISTING WOOD FRAME RESIDENTIAL BUILDINGS WITH WEAK CRIPPLE WALLS AND UNBOLTED SILL PLATES

SECTION 9201 C GENERAL

9201.1 Purpose. The provisions of this Chapter are intended to promote public safety and welfare by reducing the risk of earthquake-induced damage to existing wood-framed residential buildings. The voluntary minimum standards contained in this Chapter shall substantially improve the seismic performance of these residential buildings but will not necessarily prevent all earthquake damage. When fully followed, these standards will strengthen the portion of the structure that is most vulnerable to earthquake damage.

Prior to 1960, most wood frame residential buildings were built with raised wood floors supported by short wood stud walls known as cripple walls. These cripple walls are typically braced with weak seismic materials such as portland cement plaster or horizontal wood siding. In addition, wood frame buildings built under building codes in effect prior to July 1938 were not required to be bolted to their foundations. Recent earthquakes have shown that if a building has weak cripple walls or is unbolted, it may fall off its foundation even in moderate earthquakes. Fallen buildings have collapsed, caught fire or needed extensive repairs to restore their occupancy.

This Chapter sets prescriptive standards for strengthening of underfloor enclosures that shall be permitted by the Superintendent of Building without requiring plans or calculations prepared by an architect or an engineer. This Chapter also provides a design standard for the use of alternate materials or an alternate method of construction in lieu of the prescriptive standards. Construction documents for strengthening using alternate materials or methods shall be prepared by an architect or engineer.

9201.2 Scope. The provisions of this Chapter may be applied to light wood frame Group R, Division 1 and Division 3 Occupancies with no more than four dwelling units when they contain one or more of the structural weaknesses specified in Section 9203.1.

The provisions of this Chapter do not apply to the buildings or elements thereof, listed below. These buildings or elements require analysis by an engineer or architect in accordance with Chapter 16 or other approved standards to determine appropriate strengthening.

1. Buildings with a lateral force resisting system using poles or columns embedded in the ground.

2. Cripple walls that exceed four feet (1234 mm) in height.

3. Buildings exceeding three stories in height and any three-story building with cripple wall studs exceeding 14 inches (360 mm) in height.

4. Buildings, or portions thereof, constructed on a concrete slab on grade or constructed on or into a slope steeper than three horizontal to one vertical.

5. Buildings where the Superintendent of Building determines that conditions exist that are beyond the scope of the requirements of this Chapter.

The standard details approved by the Superintendent of Building and these prescriptive provisions are not intended to be the only acceptable strengthening methods permitted. Alternate details and methods shall be permitted when approved by the Superintendent of Building. Qualified Historical Buildings shall be permitted to use alternate building regulations or deviations from this Chapter in order to preserve their original or restored architectural elements and features. See Chapter 84 for these standards.

9201.3 Alternative Design Procedures. When analysis by an engineer or architect is required or provided for a building within the scope of this Chapter, such analysis shall be in accordance with all requirements of this Code except as provided in this Chapter. The design shall provide strengthening for any structural weakness listed in

Section 9203 that is at least equivalent to that provided by the prescriptive requirements of this Chapter with respect to strength, deflection, and capacity. The Superintendent of Building may require that sufficient evidence be submitted to substantiate such equivalence. The base shear may be determined in accordance with the following:

SECTION 9202 C DEFINITIONS

For the purpose of this Chapter, in addition to the applicable definitions, symbols and notations in this Code, certain additional terms are defined as follows:

ADHESIVE ANCHOR is a fastener placed in hardened concrete or masonry that derives its holding strength from a chemical adhesive compound placed between the wall of the hole and the embedded portion of the anchor.

ANCHOR SIDE PLATE is a metal plate or plates used to connect a sill plate to the side of a concrete or masonry stem wall.

CRIPPLE WALL is a wood-framed stud wall extending from the top of the foundation to the underside of the lowest floor framing.

EXPANSION ANCHOR is a mechanical fastener placed in hardened concrete or assembled masonry, designed to expand in a self-drilled or pre-drilled hole of a specified size and engage the sides of the hole in one or more locations to develop shear and/or tension resistance to applied loads without grout, adhesive or drypack.

PERIMETER FOUNDATION is a foundation system which is located under the exterior walls of a building.

SNUG-TIGHT is as tight as an individual can torque a nut on a bolt by hand using a wrench with a 10-inch (254 mm) long handle and the point at which the full surface of the plate washer is contacting the wood member and slightly indents the wood surface.

UNREINFORCED MASONRY includes adobe, burned clay, concrete or sand-lime brick, hollow clay or concrete block, hollow clay tile, rubble, cut stone and unburned clay masonry walls in which the area of reinforcement is less than 50 percent of the minimum steel ratios required for reinforced masonry.

SECTION 9203 C STRUCTURAL WEAKNESSES

9203.1 General. For the purpose of this Chapter, structural weaknesses shall be as specified below.

1. Sill plates or floor framing which are supported directly on the ground without an approved foundation system.

2. A perimeter foundation system which is constructed of wood posts supported on isolated pad footings.

3. Perimeter foundation systems that are not continuous.

   EXCEPTIONS: A. Existing single-story exterior walls not exceeding 10 feet (3084 mm) in length forming an extension of floor area beyond the line of an existing continuous perimeter foundation.
   B. Porches, storage rooms and similar spaces not containing fuel-burning appliances.

4. A perimeter foundation system which is constructed of unreinforced masonry.

5. Sill plates which are not connected to the foundation or are connected with less than what is required by Section 9204.3.1.

6. Cripple walls that are not braced in accordance with the requirements of Section 9204.4 and Table 92-A.

SECTION 9204 C STRENGTHENING REQUIREMENTS

9204.1 General.

9204.1.1 Scope. The structural weaknesses noted in Section 9203 shall be strengthened in accordance with the requirements of this section. Strengthening work shall be allowed to include both new construction and alteration of existing construction. Except as provided herein, all strengthening work and materials shall comply with the applicable provisions of this Code. Alternate methods of strengthening shall be allowed provided such systems are designed by an engineer or architect and approved by the Superintendent of Building.

9204.1.2 Condition of Existing Wood Materials. All existing wood materials which will be a part of the strengthening work shall be in a sound condition and free from defects which substantially reduce the capacity of the member. Any wood material found to contain fungus infection shall be removed and replaced with new material. Any wood material found to be infested with insects or to have been infested shall be strengthened or replaced with new materials to provide a net dimension of sound wood at least equal to its undamaged original dimension.

9204.1.3 Floor Joists Not Parallel to Foundations. Floor joists framed perpendicular or at an angle to perimeter foundations shall be restrained by either a nominal two-inch (51 mm) wide continuous rim joist or a nominal two-inch (51 mm) wide full depth blocking between alternate joists in one- and two-story buildings, and between each joist in three-story buildings. Blocking for multistory buildings must occur at each joist space above a braced cripple wall panel.

Existing connections at the top edge of an existing rim joist or blocking need not be verified. The bottom edge connection to either the foundation sill plate or top plate of a cripple wall shall be verified unless a supplemental connection is provided. The minimum existing bottom edge connection shall consist of 8d toe nails spaced six inches (152 mm) apart for a continuous rim joist or three 8d toe nails per block. When this minimum bottom edge connection is not present, or is not verified, a supplemental connection shall be provided.

When an existing continuous rim joist or the minimum existing blocking does not occur, new 1C inch (29 mm) wood structural panel blocking installed tightly between floor joists and nailed with 10d common nails at four inches on center to the sill or wall top plate shall be provided at the inside face of the cripple wall. In lieu of 1C inch (29 mm) wood structural panel blocking, tight fitting, full or near full depth two inches nominal width (51 mm) lumber blocking shall be allowed provided it does not split during installation. New blocking is not required where it will interfere with vents or plumbing which penetrates the wall**.**

9204.1.4 Floor Joists Parallel to Foundations. Where existing floor joists are parallel to the perimeter foundations, the end joist shall be located over the foundation and, except for required ventilation openings, shall be continuous and in continuous contact with any existing foundation sill plate or top plate of the cripple wall. Existing connections at the top edge connection of the end joist need not be verified; however, the bottom edge connection to either the foundation sill plate or the top plate of a cripple wall shall be verified unless a supplemental connection is provided. The minimum bottom edge connection shall be 8d toe nails spaced six inches (152 mm) apart. If this minimum bottom edge connection is not present or is not verified, a supplemental connection shall be provided.

9204.1.5 Supplemental Connections. Supplemental connections shall provide sufficient strength to transfer the seismic forces**.** Framing anchors of minimum 18 gauge steel and 12 approved fasteners may be considered to meet this requirement when spaced 32 inches (813 mm) on center for one story buildings, 24 inches (610 mm) on center for two story buildings and 16 inches (406 mm) on center for three story buildings.

EXCEPTION: A supplemental connection is not required when:

1. The structural wood panel sheathing extends from the sill plate to the rim joist or blocking above.
2. The floor sheathing is nailed directly into the sill or top plate of the cripple wall.

9204.1.6 Single Top Plate Ties. When a single top plate exists in the cripple wall, all end joints in the top plate shall be tied. Ties shall be connected to each end of the discontinuous top plate and shall be equal to one of the following:

1. 3-inch by 6-inch (76 mm by 152 mm) by 0.036-inch-thick (0.9 mm) galvanized steel and nailed with six 8d nails at each end.

2. 1 2 inches (38 mm) by 12-inch (305 mm) by 0.058 inches (1.47 mm) galvanized steel nailed with six 16d nails at each end.

3. 2-inch by 4-inch by 12-inch wood blocking nailed with six 16d nails at each end.

9204.2 Foundations.

9204.2.1 New Perimeter Foundations. New perimeter foundations shall be provided for structures with the structural weaknesses noted in Items 1 and 2 of Section 9203.1. Soil investigations or geotechnical studies are not required for this work unless the building shows signs of excessive settlement or creep**.**

9204.2.2 Foundation Evaluation by Engineer or Architect. Partial perimeter foundations or unreinforced masonry foundations shall be evaluated by an engineer or architect for the force levels noted in Formula (92-1). Test reports or other substantiating data to determine existing foundation material strengths shall be submitted for review. When approved by the Superintendent of Building, these foundation systems may be strengthened in accordance with the recommendations included with the evaluation in lieu of being replaced.

> **EXCEPTION:** In lieu of testing existing foundations to determine material strengths and when approved by the Superintendent of Building, a new nonperimeter foundation system, designed for the forces noted in Formula (92-1), may be used to resist all exterior wall lateral forces.

9204.2.3 Details for New Perimeter Foundations. All new perimeter foundations shall be continuous and constructed according to the standards for new buildings.

> **EXCEPTIONS:** 1. When approved by the Superintendent of Building, the existing clearance between existing floor joists or girders and existing grade below the floor need not comply with Section 2317.3. This exception shall not be permitted when buildings are relocated on new foundations.
> 2. When approved by the Superintendent of Building, and when designed by an engineer or architect, partial perimeter foundations may be used in lieu of a continuous perimeter foundation.

9204.3 Foundation Sill Plate Anchorage.

9204.3.1 Existing Perimeter Foundations. When the building has an existing continuous perimeter foundation, all perimeter wall sill plates shall be connected to the foundation in accordance with Table 92-A and this section.

Anchors shall be installed with the plate washer installed between the nut and the sill plate. The nut shall be tightened to a snug-tight condition after curing is complete for adhesive anchors and after expansion wedge engagement for expansion anchors. The installation of nuts on all anchors shall be subject to verification by the Superintendent of Building. Torque testing shall be performed for 25 percent of all adhesive or expansion anchors. Minimum test values shall be 30 foot pounds (41 N-m) for 2-inch (12.7 mm) and 40 foot pounds (55 N-m) for e-inch (15.9 mm) diameter anchors.

Anchor side plates shall be permitted when conditions prevent anchor installation vertically through the sill plate. Anchor side plates shall be spaced as required for adhesive or expansion anchors but only one anchor side plate is required on individual pieces of sill plate less than 32 inches (813 mm) in length. Wood structural panel shims shall be used on sill plates for single plate anchor side plates when the foundation stem wall is from 3/16 inch (4.8 mm) to 3/4 inch (19 mm) wider than the sill plate. The shim length shall extend a minimum of two inches (50.8 mm) past each end of the anchor side plate. Two plate anchor side plates shall be used when the total thickness of the required shim exceeds 3/4 inch (19 mm).

All anchor side plates which use lag or wood screws shall pre-drill the sill plate to prevent splitting as required by Sections 2337.1.2 and 2339.1.2. Lag or wood screws shall be installed in the center of the thickness of the existing sill plate.

Expansion anchors shall not be used in unreinforced masonry or concrete or masonry grout of poor quality. Adhesive anchors shall be required when expansion anchors will not tighten to the required torque or their installation causes surface cracking of the foundation wall.

9204.3.2 Placement of Anchors. Anchors shall be placed within 12 inches (305 mm), but not less than nine inches (229 mm), from the ends of sill plates and shall be placed near the center of the stud space closest to the required spacing. New sill plates may be installed in pieces when necessary because of existing conditions. The minimum length of new sill plate pieces shall be 30 inches (762 mm).

> **EXCEPTION:** Where physical obstructions such as fireplaces, plumbing or heating ducts interfere with the placement of an anchor, the anchor shall be placed as close to the obstruction as possible, but not less than nine inches (229 mm) from the end of the plate. Center-to-center spacing of the anchors shall be reduced as necessary to provide the minimum total number of anchors required based on the full length of the wall. Center-to-center spacing shall not be less than 12 inches (305 mm).

9204.3.3 New Perimeter Foundations. Sill plates for new perimeter foundations shall be anchored as required by Section 1806.6.

9204.4 Cripple Wall Bracing.

9204.4.1 General. Exterior cripple walls, not exceeding four feet (1219 mm) in height, shall use the prescriptive bracing method listed below. Cripple walls more than four feet (1219 mm) in height require analysis by an engineer or architect in accordance with Section 1601.

9204.4.1.1 Sheathing Requirements. Wood structural panel sheathing shall not be less than 15/32-inch (12 mm) thick. When used, plywood panels shall be constructed of five or more plies. All wood structural panels shall be nailed with 8d common nails spaced four inches (102 mm) on center at all edges and at 12 inches (305 mm) on center at each intermediate support with not less than two nails for each stud. Nails shall be driven so that their head or crown is flush with the surface of the sheathing and shall penetrate the supporting member a minimum of 1 2 inch (38 mm). When a nail fractures the surface, it shall be left in place and not counted as part of the required nailing. A new 8d nail shall be located within two inches (51 mm) of the discounted nail and hand driven flush with the sheathing surface.

> **EXCEPTION:** No. 6 x 1 2 inch (38 mm) wood screws may be used for sheathing nailing when bracing materials are installed on the interior face of studs and cement plaster or other brittle finishes are on the exterior of the sheathed wall.

All horizontal joints must occur over nominal two-inch by four-inch (51 mm by 102 mm) blocking installed with the nominal four-inch (102 mm) dimension against the face of the plywood. All vertical joints must occur over studs. Vertical joints at adjoining pieces of wood structural panels shall be centered on existing studs such that there is a minimum 1/8 inch (3.2 mm) between the panels. Nails shall be placed a minimum of 2 inch (12.7 mm) from the edges of the existing stud. When such edge distance cannot be maintained because of the width of the existing stud, a new stud shall be added adjacent to the existing and connected with 16d common nails at eight inches (206 mm) on center. A minimum of three such nails shall be provided.

9204.4.2 Distribution and Amount of Bracing. See Table 92-A for the distribution and amount of bracing required. Bracing for a building with three or more floor levels above cripple wall studs exceeding 14 inches (356 mm) in height must be designed in accordance with Chapter 16 of this code.

The braced panel must be at least two times the height of the cripple stud wall but not less than 48 inches (1219 mm) in width. All panels along a wall shall be nearly equal in length and shall be nearly equally spaced along the length of the wall. Braced panels at ends of walls shall be located as near the end as possible.

Where physical obstructions such as fireplaces, plumbing or heating ducts interfere with the placement of cripple wall bracing, the bracing shall then be placed as close to the obstruction as possible. The total amount of bracing required shall not be reduced because of obstructions but the required length of bracing need not exceed the length of the wall.

Underfloor ventilation openings shall be maintained in accordance with Section 2317.7. Braced panels may include underfloor ventilation openings when the height of the solid portion of the panel meets or 75 percent of the height of the cripple stud wall. When the minimum amount of bracing prescribed in Table 92-A cannot be installed due to obstructions along any wall, the bracing must be designed by an architect or engineer in accordance with Section 9201.3**.**

9204.4.3 Stud Space Ventilation. When bracing materials are installed on the interior face of studs forming an enclosed space between the new bracing and existing exterior finish, each braced stud space must be ventilated. Adequate ventilation and access for future inspection shall be provided by drilling on two-inch to three-inch (51 mm to 76 mm) diameter round hole through the sheathing nearly centered between each stud at the top and bottom of the cripple wall. Such holes should be spaced a minimum of one-inch (25 mm) clear from the sill or top plates. In stud spaces containing sill bolts, the hole shall be located on the center line of the sill bolt but not closer than one-inch (25 mm) clear from the nailing edge of the sheathing.

When existing blocking occurs within the stud space, additional ventilation holes shall be placed above and below the blocking or the existing block shall be removed and a new nominal two-inch (51 mm) by four-inch (102 mm) block installed with the nominal four-inch (102 mm) dimension against the face of the plywood. For stud heights less than 18 inches (457 mm) only one ventilation hole need be provided.

9204.4.4 Existing Underfloor Ventilation. Existing underfloor ventilation shall not be reduced without providing equivalent new ventilation as close to the existing as possible. New sheathing may be installed around existing vent openings in braced panels when the length of the panel is increased a distance equal to the length of the vent opening or one stud space minimum.

> **EXCEPTION:** For residential buildings with a post and pier foundation system where a new continuous perimeter foundation system is being installed, ventilation shall be provided in accordance with this Code.

SECTION 9205 C QUALITY CONTROL

9205.1 Inspection by the Department. All work shall be subject to inspection by the Superintendent of Building including, but not limited to:

1. Placement and installation of new adhesive or expansion anchors or anchor side plates installed in existing foundations.

2. Placement of required blocking and framing anchors.

3. Installation and nailing of new cripple wall bracing.

The torque testing of sill plate anchors per Section 9204.3.1 shall be performed by the building inspector.

9205.2 Special Inspection. Special inspection is not required for sill plate anchors installed in existing foundations regulated by the provisions of this Chapter. Any work may be subject to special inspection when required by the Superintendent of Building or when so designated by the architect or engineer of record.

9205.3 Structural Observation. Structural observation is not required for work done under the prescriptive provisions of this Chapter. When construction documents for strengthening are prepared by an architect or engineer and alternate materials or methods are used, structural observation shall be provided as required in Section 1702.

9205.4 Engineer's or Architect's Statement. When an alternative design is provided per Section 9201.3, the responsible engineer or architect shall place the following statement on the approved plans:

1. AI am responsible for this building's seismic strengthening design for the underfloor cripple walls and sill bolting in compliance with the minimum seismic resistance standards of Chapter 92 of the Los Angeles Building Code.@

or when applicable:

2. AThe Registered Deputy Inspector, required as a condition of the use of structural design stresses requiring continuous inspection, will be responsible to me as required by Section 1701.1 of the Los Angeles Building Code.@

TABLE 92-A C SILL PLATE ANCHORAGE AND CRIPPLE WALL BRACING [1,2,3]

Number of Stories above Cripple Walls	Minimum Sill Plate Connection and Maximum Spacing	Amount of Wall Bracing
One Story	Adhesive or expansion anchors shall be 2-inch (12.7 mm) minimum diameter spaced at six feet (1829 mm) maximum center to center.	Each end and not less than 50% of the wall length.
Two Story	Adhesive or expansion anchors shall be 2-inch (12.7 mm) minimum diameter spaced at four feet (1219 mm) maximum center to center; or 5/8 inch (15.9 mm) spaced at six feet maximum center to center.	Each end and not less than 70% of the wall length.
Three Story	Adhesive or expansion anchors shall be 2- inch minimum (12.7 mm) diameter spaced at two feet eight inches (813 mm) maximum center to center; or 5/8-inch minimum (15.9 mm) diameter spaced at four feet (1219 mm) maximum center to center.	100% of the wall length.

[1] Plate washers for use with adhesive or expansion anchors shall be two-inch (51 mm) by two-inch (51 mm) by 3/16-inch (4.8 mm) for 2-inch (12.7 mm) diameter anchors and 22-inch (64 mm) by 22-inch (64 mm) by 1/4-inch (6 mm) for 5/8 inch (15.9 mm) diameter anchors.

[2] Existing sill plate anchor bolts shall be permitted to provide all or a portion of the sill plate connection requirement if:

a. the anchor bolt is cast in concrete and in sound condition, and:
b. the diameter size and maximum spacing meets or exceeds the requirements of Table 92-A, and:
c. a new plate washer conforming to footnote 1 is installed, and:
d. the sill plate is connected to a snug tight condition and torque tested per Section 9204.3.1.

[3] Anchor side plates shall be permitted when conditions prevent anchor installation vertically through the sill plate.

***

Appendix B REAL ESTATE DISCLOSURE REQUIREMENTS

CALIFORNIA GOVERNMENT CODE

SECTION 8897.1-8897.5

Section 8897.1.

(a) After January 1, 1993, the transferor of any real property containing any residential dwelling built prior to January 1, 1960, with one to four living units of conventional light-frame construction, as defined in Chapter 25 of the 1991 Edition of the Uniform Building Code of the International Conference of Building Officials, shall, as soon as practicable before the transfer, deliver to the purchaser or transferee a copy of the "Homeowner's Guide to Earthquake Safety" published pursuant to Section 10149 of the Business and Professions Code and complete the earthquake hazards disclosure regarding the property. The earthquake hazards disclosure shall clearly indicate whether the transferor has actual knowledge that the dwelling has any of the deficiencies listed in Section 8897.2.

(b) The transferor shall make the earthquake hazards disclosure as soon as practicable before the transfer of title in the case of a sale or exchange, or prior to execution of the contract where the transfer is by a real property sales contract, as defined in Section 2985. For purposes of this subdivision, the disclosure may be made in person or by mail to the transferee, or to any person authorized to act for him or her in the transaction, or to additional transferees who have requested delivery from the transferor in writing.

(c) This article does not apply to any of the following:

(1) Transfers which are required to be preceded by the furnishing to a prospective transferee of a copy of a public report pursuant to Section 11018.1 of the Business and Professions Code.
(2) Transfers pursuant to court order, including, but not limited to, transfers ordered by a probate court in the administration of an estate, transfers pursuant to a writ of execution, transfers by a trustee in bankruptcy, transfers by eminent domain, or transfers resulting from a decree for specific performance.
(3) Transfers to a mortgagee by a mortgagor in default, transfers to a beneficiary of a deed of trust by a trustor in default, transfers by any foreclosure sale after default, transfers by any foreclosure sale after default in an obligation secured by a mortgage, or transfers by a sale under a power of sale after a default in an obligation secured by a deed of trust or secured by any other instrument containing a power of sale and, any subsequent transfer by a mortgagor or beneficiary of a deed of trust who accepts a deed in lieu of foreclosure or purchases the property at a foreclosure sale.
(4) Transfers by a fiduciary in the course of the administration of a decedent's estate, guardianship, conservatorship, or trust.
(5) Transfers from one coowner to one or more coowners.
(6) Transfers made to a spouse, or to a person or persons in the lineal line of consanguinity of one or more of the transferors.
(7) Transfers between spouses resulting from a decree of dissolution of a marriage, from a decree of legal separation, or from a property settlement agreement incidental to either of those decrees.
(8) Transfers by the Controller in the course of administering the Unclaimed Property Law provided for in Chapter 7 (commencing with Section 1500) of Title 10 of Part 3 of the Code of Civil Procedure.
(9) Transfers under the provisions of Chapter 7 (commencing with Section 3691) or Chapter 8 (commencing with Section 3771) of Part 6 of Division 1 of the Revenue and Taxation Code.
(10) Transfers for which the transferee has agreed in writing that the dwelling will be demolished within one year of the date of transfer.

8897.2. (a) The transferor shall disclose any of the following deficiencies which are within the transferor's actual knowledge and material to the transaction, and which may increase a dwelling's vulnerability to earthquake damage:

(1) The absence of anchor bolts securing the sill plate to the foundation.

(2) The existence of perimeter cripple walls that are not braced with plywood, blocking, or diagonal metal or wood braces.

(3) The existence of a first-story wall or walls that are not braced with plywood or diagonal metal or wood braces.

(4) The existence of a perimeter foundation composed of unreinforced masonry.

(5) The existence of unreinforced masonry dwelling walls.
(6) The existence of a habitable room or rooms above a garage.
(7) The existence of a water heater which is not anchored, strapped, or braced.

(b) The transferor shall be required to disclose any material information within the transferor's actual knowledge regarding any corrective measures or improvements taken to address the items listed in subdivision (a).

8897.3. (a) For the purposes of this chapter, if it is determined that retrofit work is appropriate to address potential deficiencies listed in paragraph (1) or (2) of subdivision (a) of Section 8897.2, the following standards shall be used:

(1) The foundation anchor bolt requirements of subdivision (f) of Section 2907 of Chapter 29 of the 1991 Edition of the Uniform Building Code of the International Conference of Building Officials, or any local government modification which establishes equivalent or higher requirements.
(2) The cripple wall bracing requirements of paragraph (4) of subdivision (g) of Section 2517 of Chapter 25 of the 1991 Edition of the Uniform Building Code of the International Conference of Building Officials, or any local government modification which establishes equivalent or higher requirements.
(3) The water heater bracing, anchoring, or strapping requirements to resist falling or horizontal displacement due to earthquake motion of Section 19215 of the Health and Safety Code.

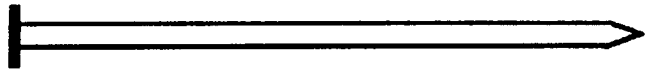
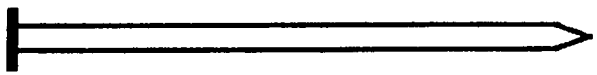
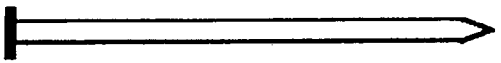
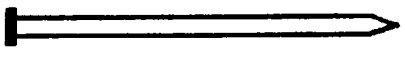
(b) Any qualified historical building or structure, as defined pursuant to Section 18955 of the Health and Safety Code, shall be permitted to utilize alternatives to the requirements of this section, as provided by the State Historical Building Code (Part 2.7 (commencing with Section 18950) of Division 13 of the Health and Safety Code) and the regulations issued pursuant thereto.

8897.4. No transfer of title shall be invalidated on the basis of a failure to comply with this chapter.

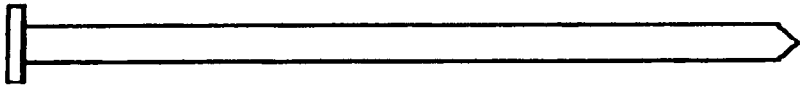
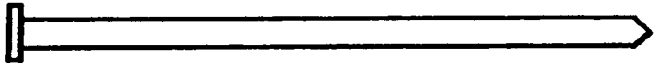
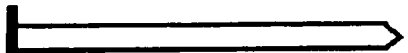
8897.5. For the purposes of this chapter, the duty of the real estate licensee shall be limited to providing to the seller a copy of the Homeowner's Guide to Earthquake Safety for delivery to the prospective transferee pursuant to Section 2079.8 of the Civil Code.

Appendix C FULL SCALE NAIL CHARTS

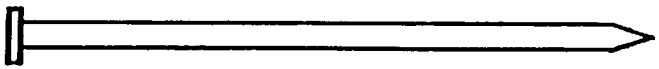
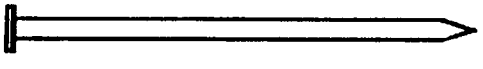
FULL SCALE NAIL CHART

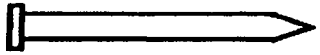
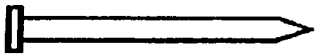
BOX	Wire Diam.	Wire Gage	LENGTH	BOX NAIL
20d	.148	9	4"	
16d	.135	10	3 1/2"	
12d	.128	10.5	3 1/4"	
10d	.128	10.5	3"	
8d	.113	11.5	2 1/2"	
6d	.099	10.5	2"	

FULL SCALE NAIL CHART

COMMON	Wire Diam.	Wire Gage	LENGTH	
20d	.192	6	4"	
16d	.162	8	3 1/2"	
12d	.148	9	3 1/4"	
10d	.148	9	3"	
8d	.131	10.25	2 1/2"	
6d	.113	11.5	2"	

FULL SCALE NAIL CHART

GREEN VINYL SINKERS	Wire Diam.	Wire Gage	LENGTH	GREEN VINYL SINKERS
16d	.148	9	3 1/4"	
8d	.113	11 1/2	2 3/8"	

JOIST HANGER	Wire Diam.	Wire Gage	LENGTH	JOIST HANGER
10d	.148	9	1 1/2"	
8d	.131	10 1/4	1 1/2"	

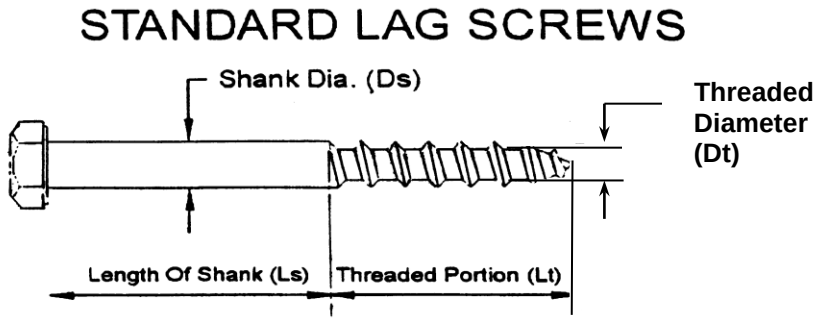
Appendix D PRE-DRILLED HOLE SIZES

Predrilled Holes for Nails

Less than 75% of nail diameter

	PREDRILL HOLE SIZE
COMMON	
20d	1/8"
16d	1/8"
12d	3/32"
10d	3/32"
8d	3/32"
6d	1/16"
BOX	
20d	3/32"
16d	3/32"
12d	3/32"
10d	3/32"
8d	1/16"
6d	1/16"
GREEN VINYL SINKERS	
16d	3/32"
8d	1/16"
JOIST HANGERS	
10d	3/32"
8d	3/32"

Predrilled Holes for Standard Lag Screws

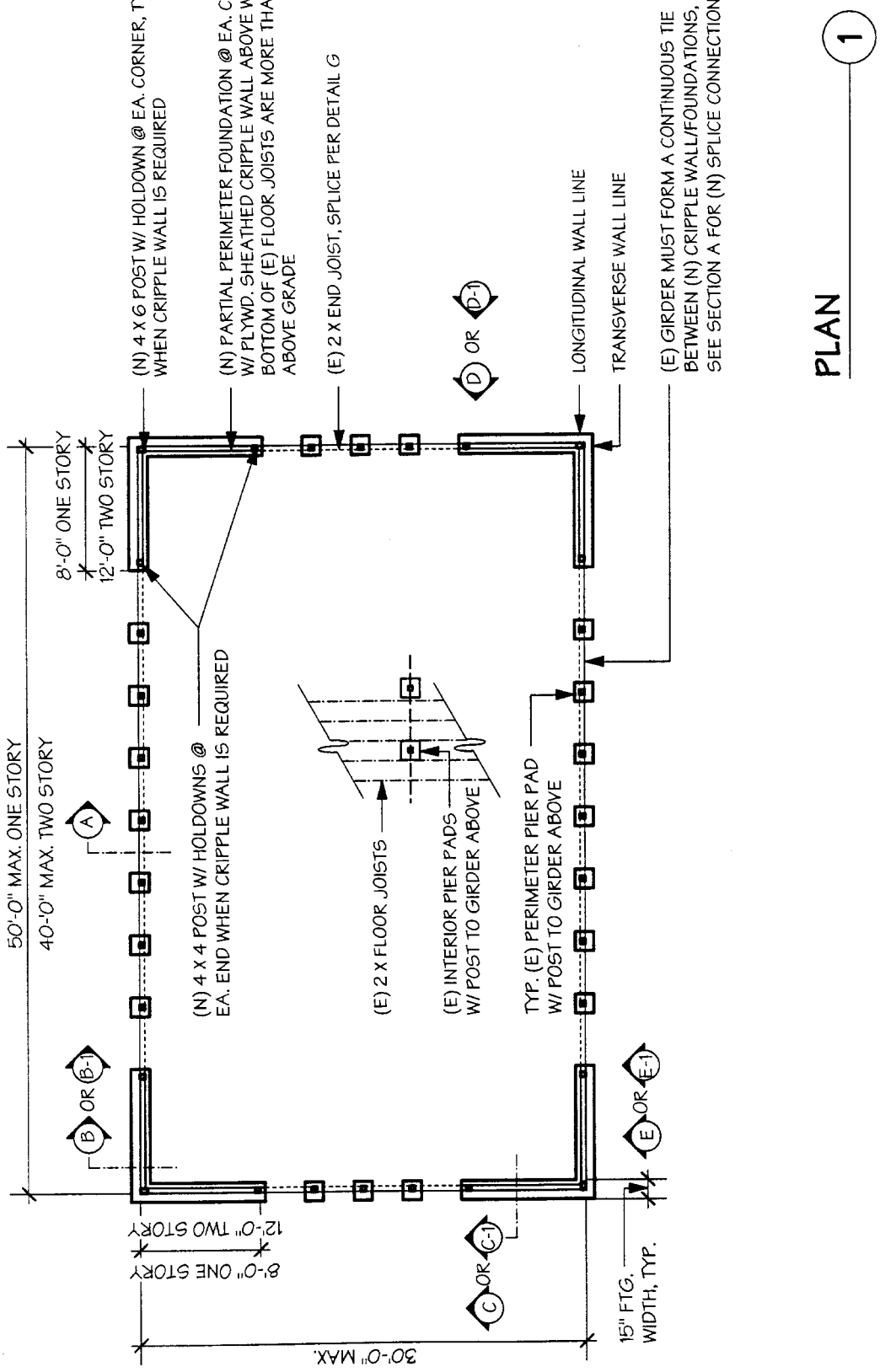


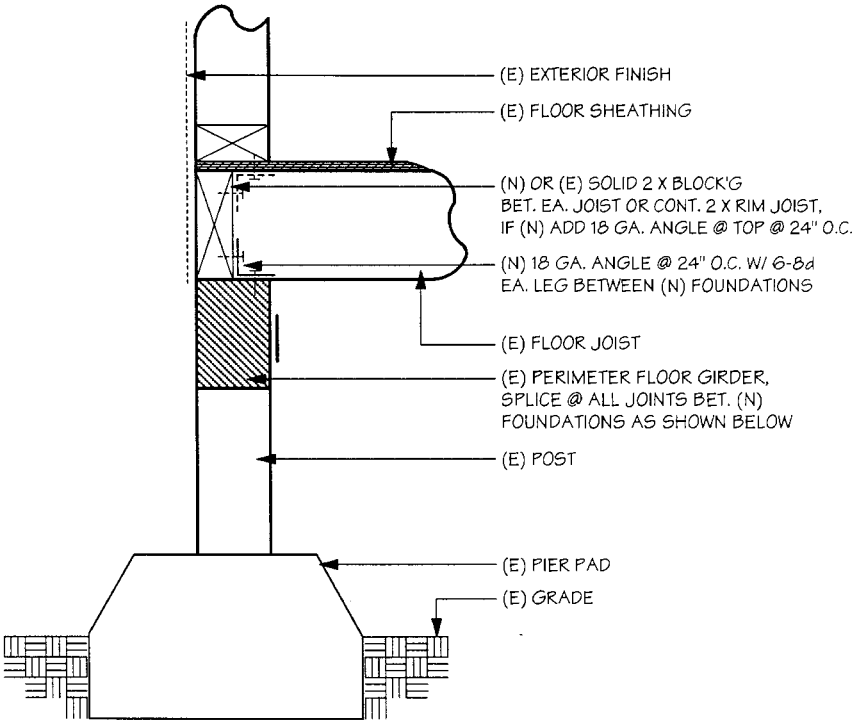
	PREDRILL HOLE SIZE	
LAG SCREW	SHANK DIAMETER	THREAD DIAMETER
3/4"	3/4"	1/2"
5/8"	5/8"	7/16"
1/2"	1/2"	5/16"
7/16"	7/16"	1/4"
3/8"	3/8"	3/16"
5/16"	5/16"	5/32"
1/4"	1/4"	1/8"

PROCEDURE:

1. Drill thread diameter (D_T) to a depth equal to length of lag screw ($L_T + L_S$).
2. Drill shank diameter (D_S) to a depth equal to shank length (L_S). Do NOT over drill shank diameter.

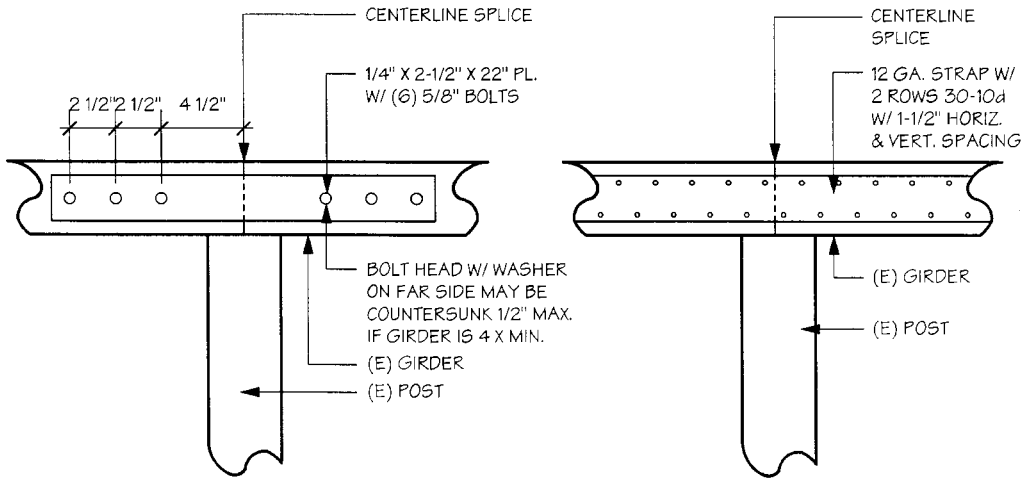
Appendix E PARTIAL PERIMETER DETAILS


(N) 4 X 6 POST W/ HOLDOWN @ EA. CORNER, TYP. WHEN CRIPPLE WALL IS REQUIRED
(N) PARTIAL PERIMETER FOUNDATION @ EA. CORNER W/ PLYWD. SHEATHED CRIPPLE WALL ABOVE WHEN BOTTOM OF (E) FLOOR JOISTS ARE MORE THAN 3'-0" ABOVE GRADE
(E) 2 X END JOIST, SPLICE PER DETAIL G
D OR D-1
LONGITUDINAL WALL LINE
TRANSVERSE WALL LINE
(E) GIRDER MUST FORM A CONTINUOUS TIE BETWEEN (N) CRIPPLE WALL/FOUNDATIONS, SEE SECTION A FOR (N) SPLICE CONNECTIONS
8'-0" ONE STORY
12'-0" TWO STORY
50'-0" MAX. ONE STORY
40'-0" MAX. TWO STORY
A
(N) 4 X 4 POST W/ HOLDOWNS @ EA. END WHEN CRIPPLE WALL IS REQUIRED
(E) 2 X FLOOR JOISTS
(E) INTERIOR PIER PADS W/ POST TO GIRDER ABOVE
TYP. (E) PERIMETER PIER PAD W/ POST TO GIRDER ABOVE
B OR B-1
E OR E-1
C OR C-1
12'-0" TWO STORY
8'-0" ONE STORY
30'-0" MAX.
15" FTG. WIDTH, TYP.
PLAN
1



SECTION ALONG (E) EXTERIOR WALL BETWEEN (N) FOUNDATIONS

A



(E) PERIMETER GIRDER SPLICE 2

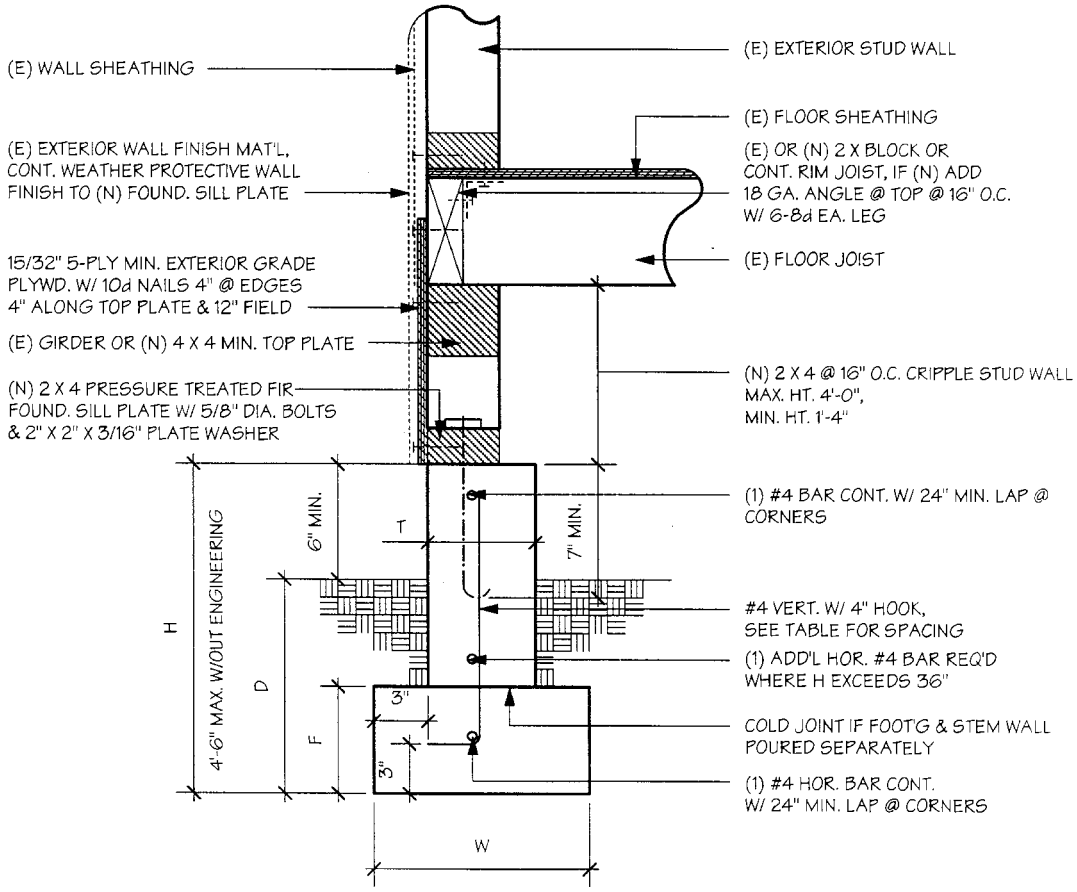
ALTERNATE 1 / (E) PERIMETER GIRDER SPLICE 1

MINIMUM FOUNDATION DIMENSIONS

# OF STORIES	W	F	D[1]	T
1	15"	7"	12"	6"
2	15"	7"	18"	8"

[1] WHERE FROST CONDITIONS OCCUR, THE MIN. DEPTH SHALL EXTEND BELOW FROST LINE

# OF STORIES	MINIMUM VERTICAL REINFORCING
1	4-#4 IN EA. 8'-0" SECTION, 30" O.C. MAX.
2	7-#4 IN EA. 12'-0" SECTION, 24" O.C. MAX.



SECTION ALONG LONGITUDINAL WALL
@ (N) FOUNDATION / CRIPPLE WALL B

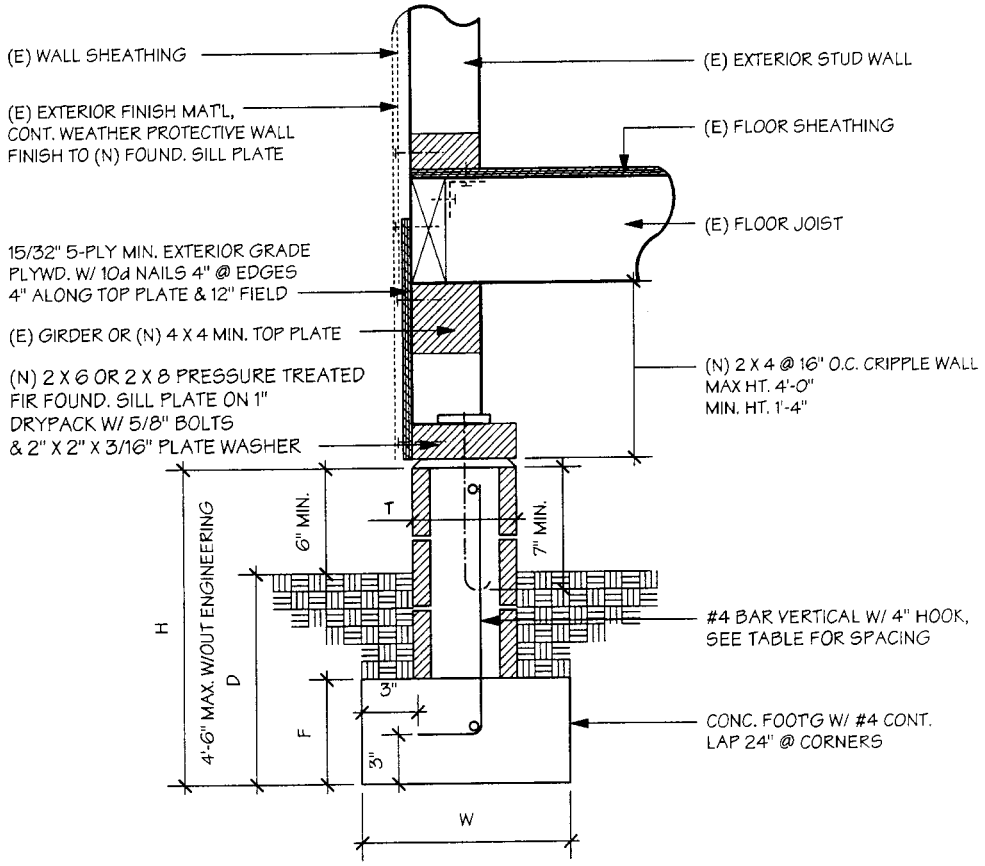
MINIMUM FOUNDATION DIMENSIONS

# OF STORIES	W	F	D[1]	T
1	15"	7"	12"	6"
2	15"	7"	18"	8"

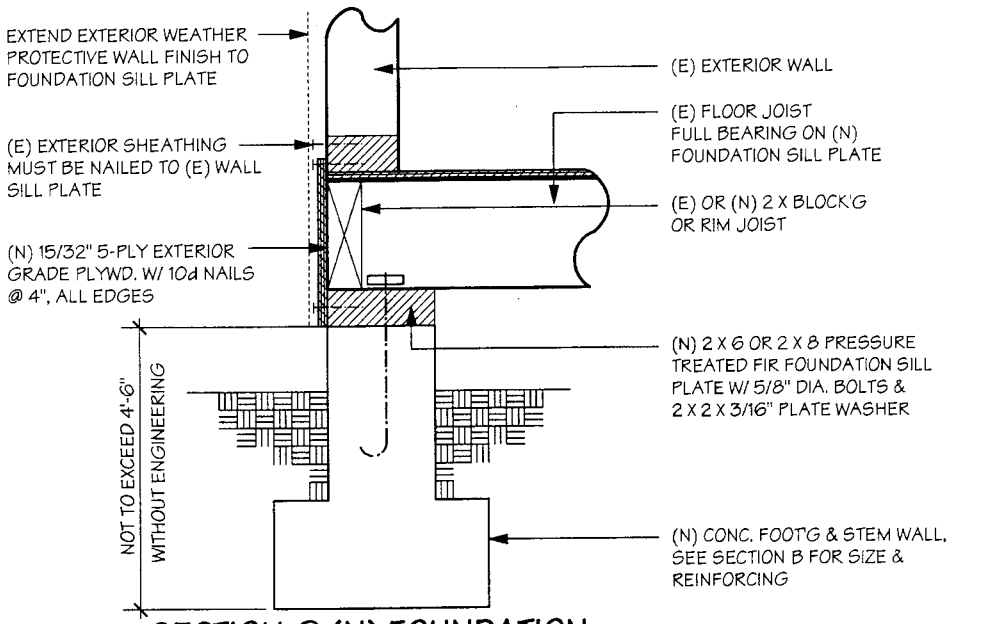
MINIMUM FOUNDATION REINFORCING

H	VERTICAL	HORIZONTAL LAP 24" @ CORNERS
$\leq$ 24"	#4 @ 24" O.C.	#4 CONT. @ TOP OF STEM WALL
> 24" $\leq$ 54"	#4 @ 24" O.C.	#4 @ 16" O.C.

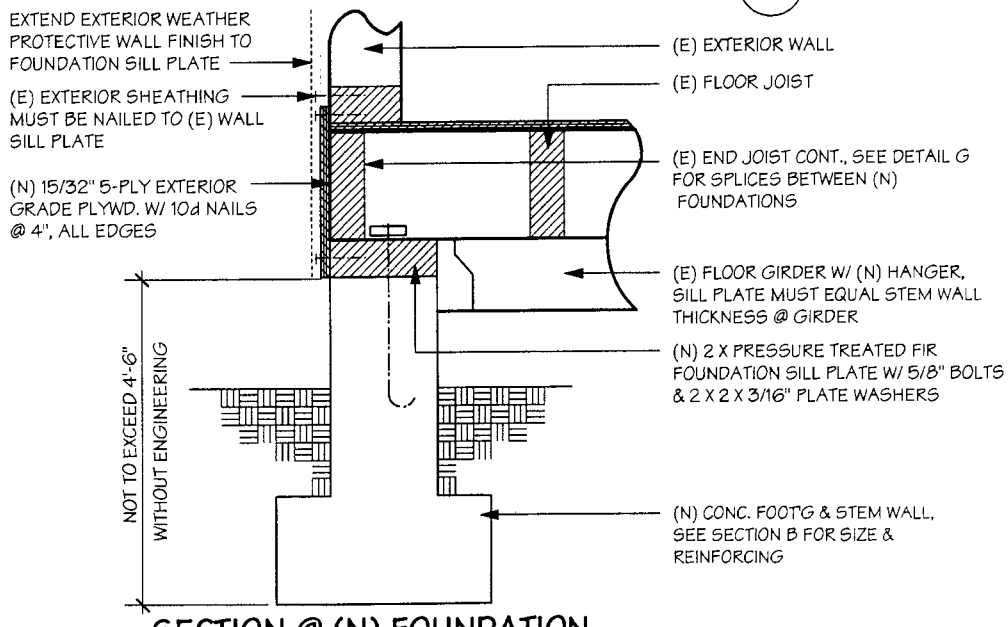
[1] WHERE FROST CONDITIONS OCCUR, THE MIN. DEPTH SHALL EXTEND BELOW FROST LINE.



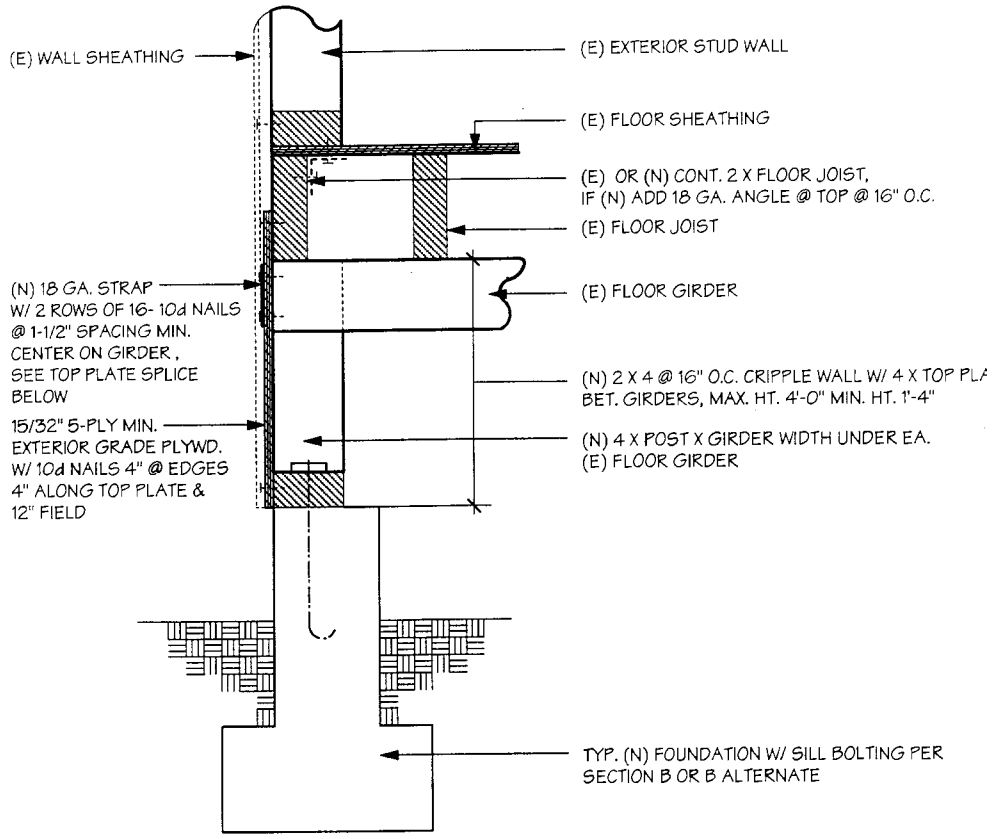
SECTION - MASONRY STEM WALL ALTERNATE B



SECTION @ (N) FOUNDATION WITHOUT CRIPPLE WALL B-1

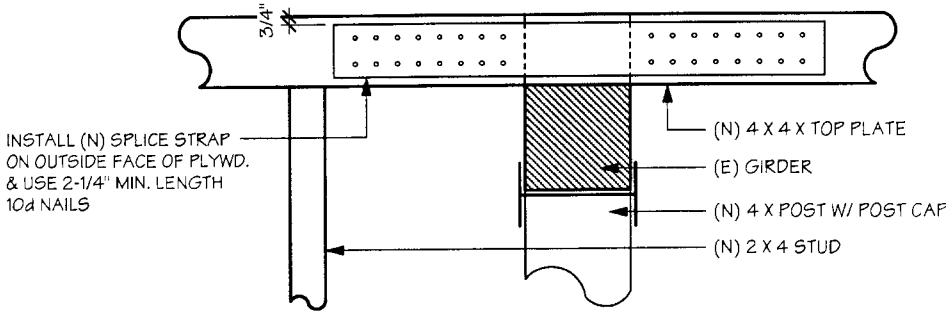


SECTION @ (N) FOUNDATION WITHOUT CRIPPLE WALL C-1



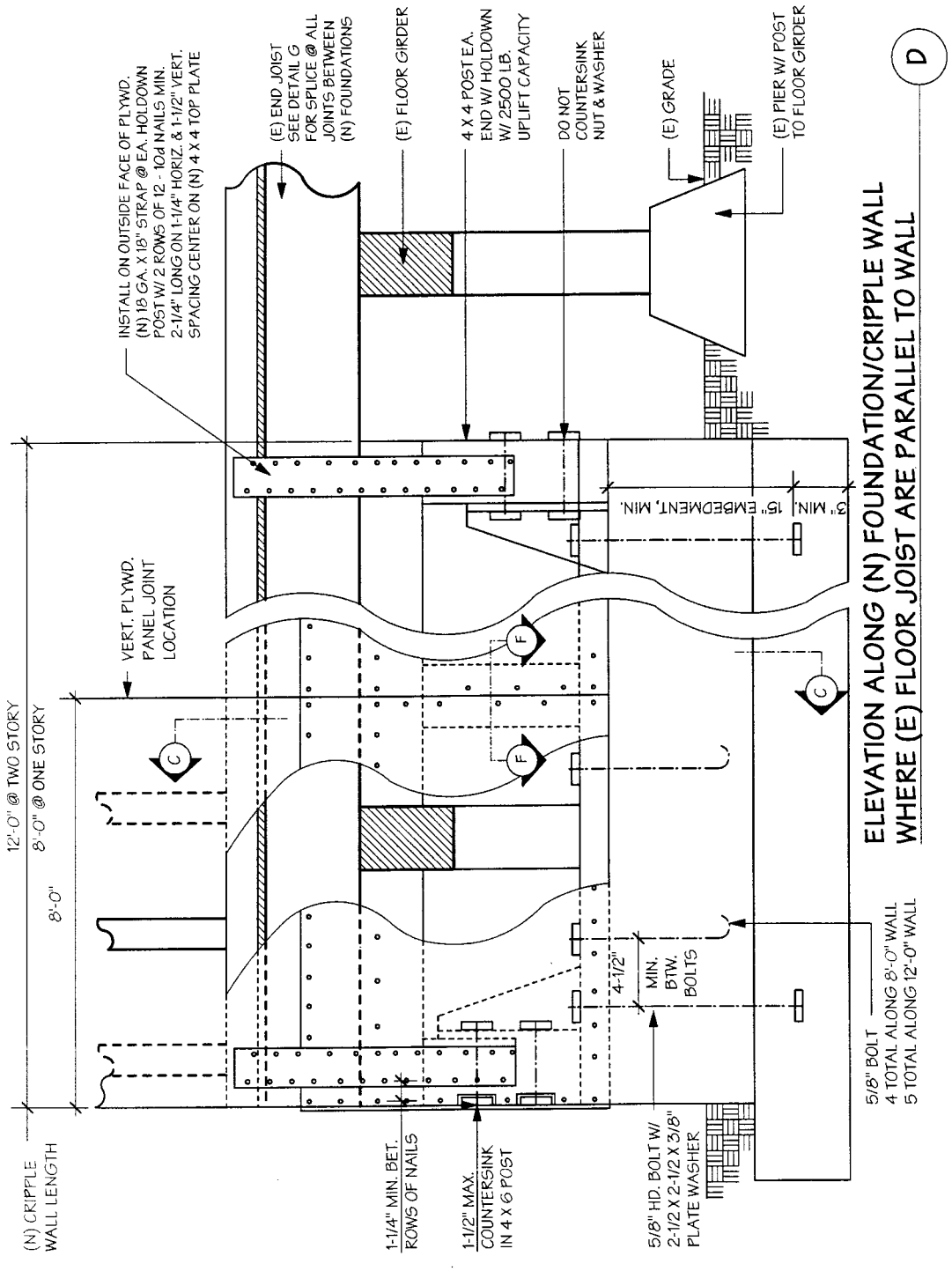
SECTION ALONG TRANSVERSE WALL
@ GIRDER INTERSECTING (N) CRIPPLE WALL

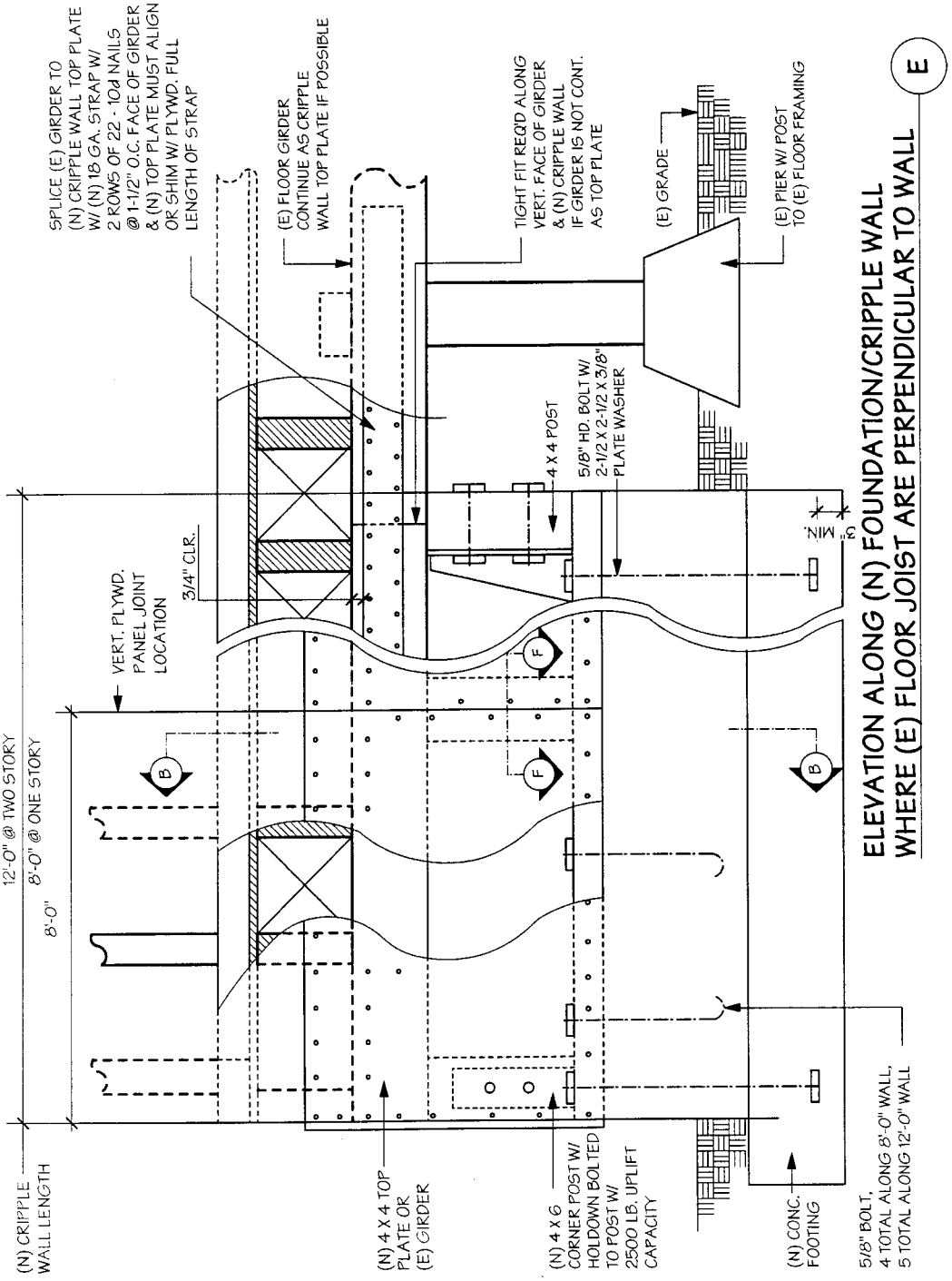
C

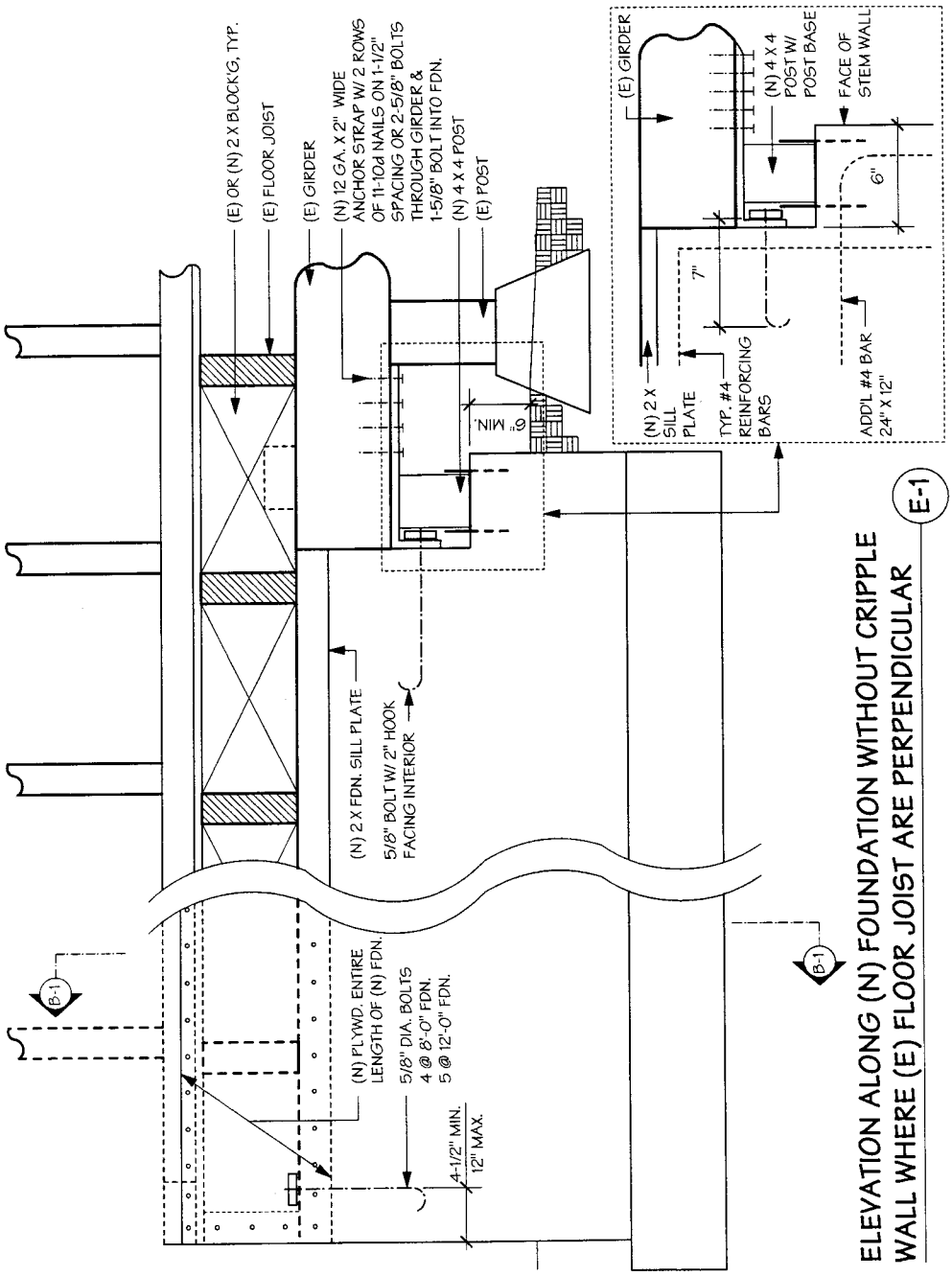


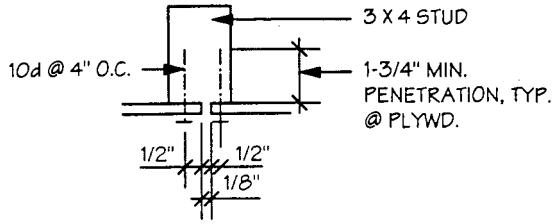
TRANSVERSE WALL
TOP PLATE SPLICE @ GIRDER

1

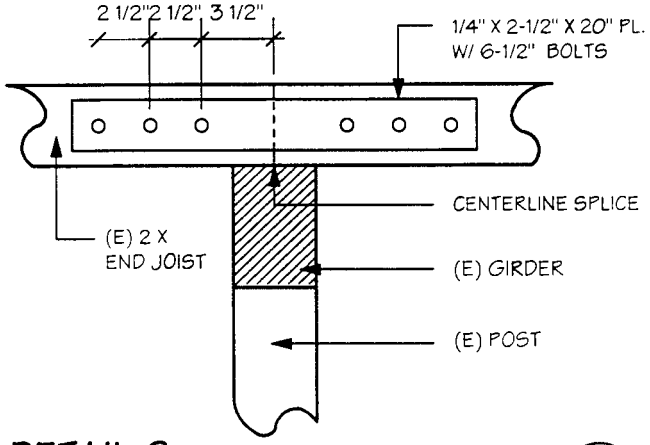

INSTALL ON OUTSIDE FACE OF PLYWD.
(N) 18 GA. X 18" STRAP @ EA. HOLDOWN
POST W/ 2 ROWS OF 12 - 10d NAILS MIN.
2-1/4" LONG ON 1-1/4" HORIZ. & 1-1/2" VERT.
SPACING CENTER ON (N) 4 X 4 TOP PLATE
(E) END JOIST
SEE DETAIL G
FOR SPLICE @ ALL
JOINTS BETWEEN
(N) FOUNDATIONS
(E) FLOOR GIRDER
4 X 4 POST EA.
END W/ HOLDOWN
W/ 2500 LB.
UPLIFT CAPACITY
DO NOT
COUNTERSINK
NUT & WASHER
(E) GRADE
(E) PIER W/ POST
TO FLOOR GIRDER
D
VERT. PLYWD.
PANEL JOINT
LOCATION
12'-0" @ TWO STORY
8'-0" @ ONE STORY
8'-0"
(N) CRIPPLE
WALL LENGTH
3" MIN.
15" EMBEDMENT, MIN.
C
F
F
C
4-1/2"
MIN.
BTW.
BOLTS
1-1/4" MIN. BET.
ROWS OF NAILS
1-1/2" MAX.
COUNTERSINK
IN 4 X 6 POST
5/8" HD. BOLT W/
2-1/2 X 2-1/2 X 3/8"
PLATE WASHER
5/8" BOLT
4 TOTAL ALONG 8'-0" WALL
5 TOTAL ALONG 12'-0" WALL
ELEVATION ALONG (N) FOUNDATION/CRIPPLE WALL
WHERE (E) FLOOR JOIST ARE PARALLEL TO WALL


SPLICE (E) GIRDER TO (N) CRIPPLE WALL TOP PLATE W/ (N) 18 GA. STRAP W/ 2 ROWS OF 22 - 10d NAILS @ 1-1/2" O.C. FACE OF GIRDER & (N) TOP PLATE MUST ALIGN OR SHIM W/ PLYWD. FULL LENGTH OF STRAP
(E) FLOOR GIRDER CONTINUE AS CRIPPLE WALL TOP PLATE IF POSSIBLE
TIGHT FIT REQ'D ALONG VERT. FACE OF GIRDER & (N) CRIPPLE WALL IF GIRDER IS NOT CONT. AS TOP PLATE
(E) GRADE
(E) PIER W/ POST TO (E) FLOOR FRAMING
4 X 4 POST
5/8" HD. BOLT W/ 2-1/2 X 2-1/2 X 3/8" PLATE WASHER
3" MIN.
VERT. PLYWD. PANEL JOINT LOCATION
3/4" CLR.
12'-0" @ TWO STORY
8'-0" @ ONE STORY
8'-0"
(N) CRIPPLE WALL LENGTH
(N) 4 X 4 TOP PLATE OR (E) GIRDER
(N) 4 X 6 CORNER POST W/ HOLDOWN BOLTED TO POST W/ 2500 LB. UPLIFT CAPACITY
(N) CONC. FOOTING
5/8" BOLT, 4 TOTAL ALONG 8'-0" WALL, 5 TOTAL ALONG 12'-0" WALL
B
F
E
ELEVATION ALONG (N) FOUNDATION/CRIPPLE WALL
WHERE (E) FLOOR JOIST ARE PERPENDICULAR TO WALL

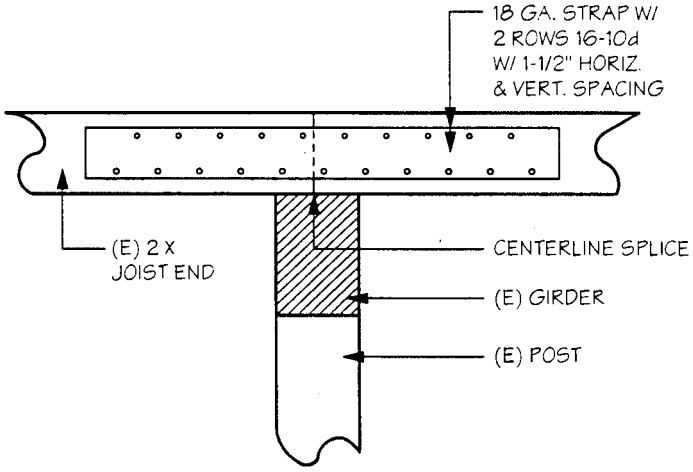

(E) OR (N) 2 X BLOCK'G, TYP.
(E) FLOOR JOIST
(E) GIRDER
(N) 12 GA. X 2" WIDE ANCHOR STRAP W/ 2 ROWS OF 11-10d NAILS ON 1-1/2" SPACING OR 2-5/8" BOLTS THROUGH GIRDER & 1-5/8" BOLT INTO FDN.
(N) 4 X 4 POST
(E) POST
6" MIN.
(N) 2 X FDN. SILL PLATE
5/8" BOLT W/ 2" HOOK FACING INTERIOR
(N) PLYWD. ENTIRE LENGTH OF (N) FDN.
5/8" DIA. BOLTS 4 @ 8'-0" FDN. 5 @ 12'-0" FDN.
4-1/2" MIN. 12" MAX.
B-1
(E) GIRDER
(N) 4 X 4 POST W/ POST BASE
FACE OF STEM WALL
6"
7"
(N) 2 X SILL PLATE
TYP. #4 REINFORCING BARS
ADD'L #4 BAR 24" X 12"
ELEVATION ALONG (N) FOUNDATION WITHOUT CRIPPLE WALL WHERE (E) FLOOR JOIST ARE PERPENDICULAR
E-1



SECTION @ FF
VERTICAL PANEL JOINT — F



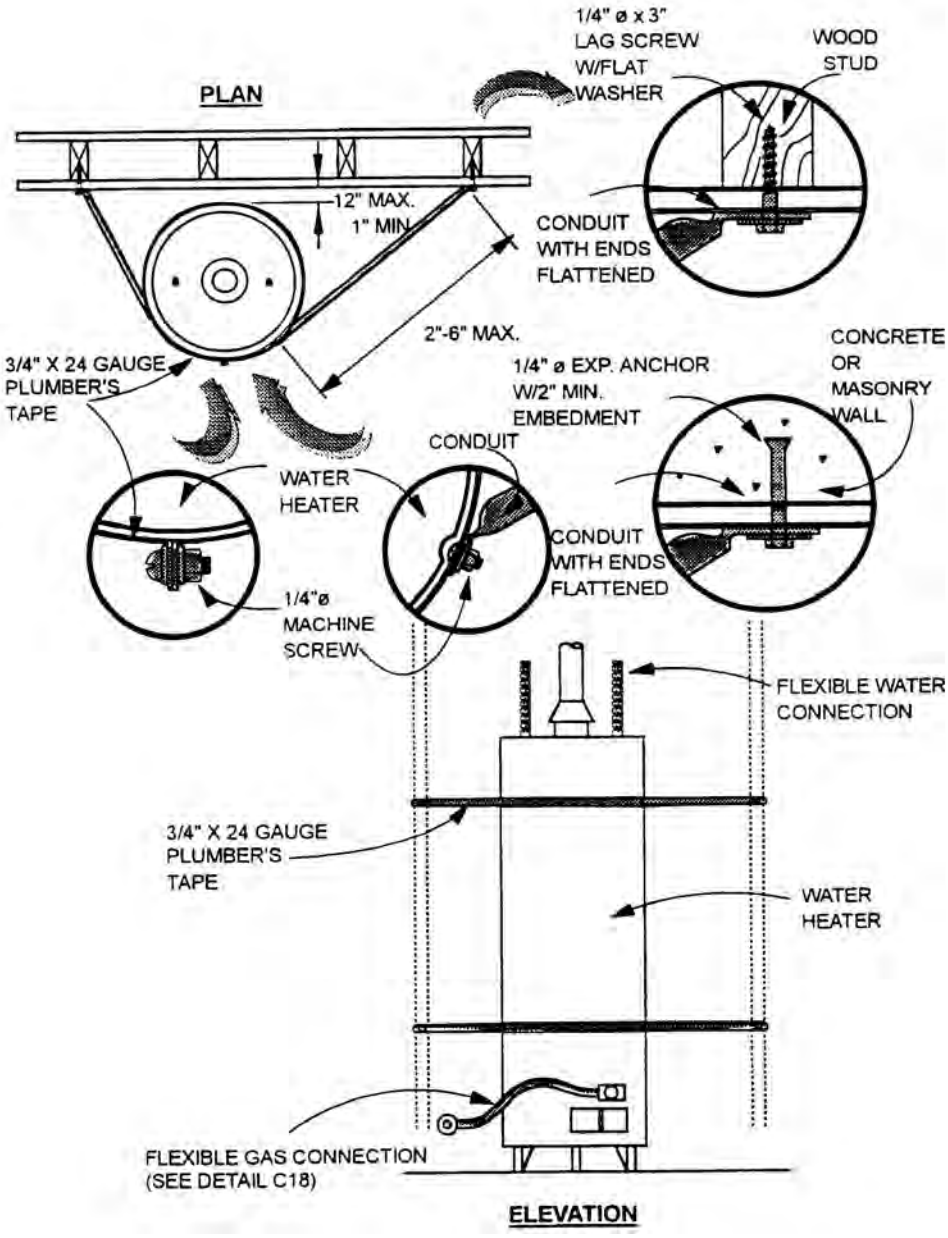
DETAIL G — G



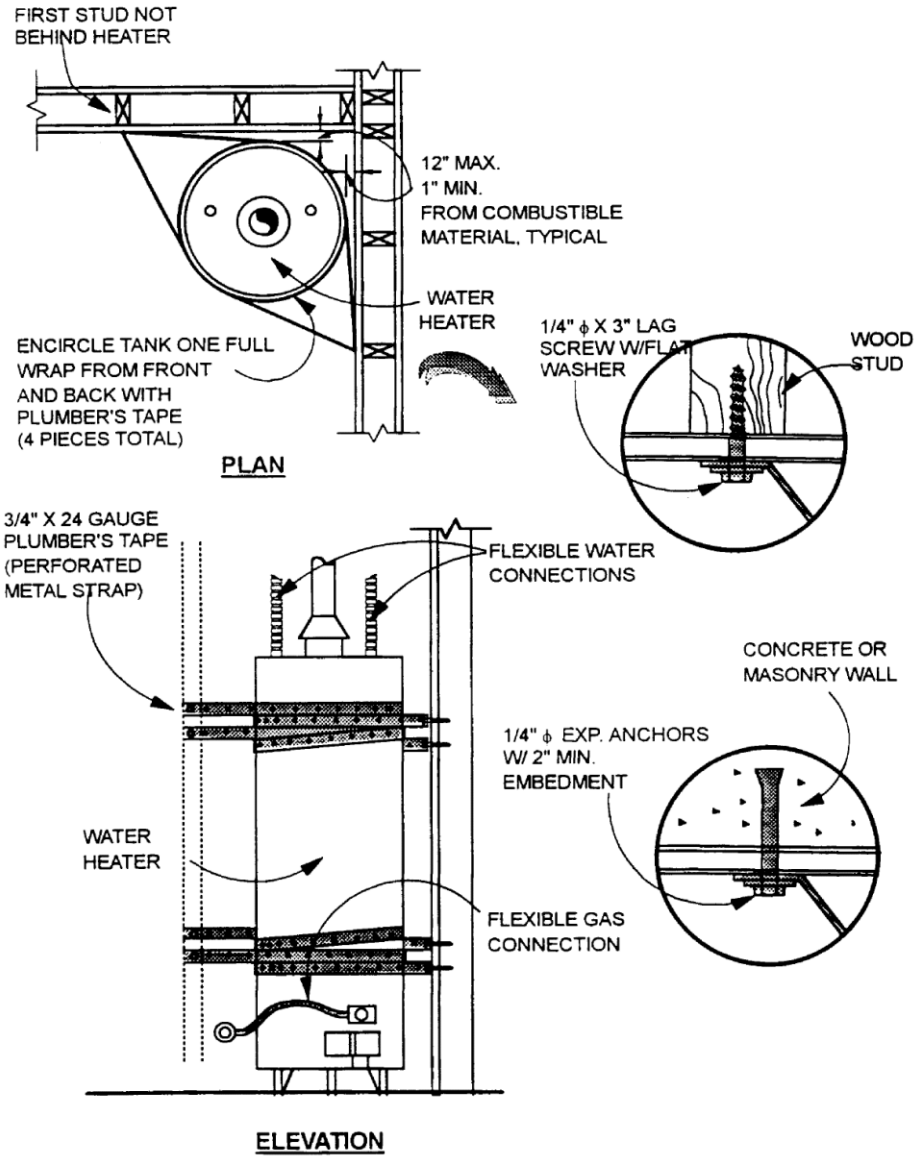
DETAIL G ALTERNATE — G-2

Appendix F WATER HEATER BRACING ILLUSTRATIONS

FLAT WALL BRACING



CORNER BRACING



Appendix G HOME IMPROVEMENT CONTRACT FORM

HOME IMPROVEMENT CONTRACT FORM

_____ ("Owner") hereby retains _____ Construction ("Contractor") located at _____, California, bearing California Contractor's License No. _____, to construct the following described work of improvement (the "project"):

1. Description of Work. Contractor shall furnish all labor and materials necessary to construct and complete in a good, workmanlike and prompt manner, pursuant to the project plans and applicable law, the improvements to the project located at _____, California (the "premises") as described hereafter.

The following specifically described work is included:

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

k.

l.

All improvements and included in this Contract shall constitute the "work" of improvement as to the premises.

The project shall be constructed with workmanship and materials which are timely approved by the owner, which approval shall not be unreasonably withheld.

Owner shall timely communicate with the contractor to provide contractor an opportunity to exercise such approval rights as appropriate as the project progresses.

The following items of work are not included in the work:

a

b.

c.

d.

e.

f.

g.

h.

2. Construction Funds. The financing for this project shall be provided by an appropriate loan to the owner from its lender whereby some other specified source of funds as provided below:

The construction of this project shall be managed from the financial standpoint by the _____ Builders Control.

3. Property Lines. As the work will be completed within the confines of the existing property where the premises is located, or has no responsibility to locate and point out property lines to the contractor. There will be no need for a licensed land surveyor map on the property.

4. Price and Terms.

All of the above work is to be completed in a workmanlike manner according to the standards, practices and applicable codes for the sum of $_____. Contractor understands that it is completing all necessary and appropriate seismic, energy conservation, heating and cooling improvements pursuant to applicable law, and pursuant to all applicable standards and industry practice.

Progress payments for the work are to be made in the course of terms and conditions hereinafter set forth, upon owner's approval of completion of the work as to each indicated stage indicated hereafter.

Amount of Work or Services To Be Performed or Description Of Any Material and Equipment To Be Supplied	Amount of Payment
When Ready for Concrete	20%
When Rough Framed	20%
When Drywall is Installed	20%
When Tile Completed	20%
When Job Completed	20%

5. Certificate of Completion Work.

Owner shall receive written certification from Contractor of completion of each day. Owner has the right to retain an appropriate construction inspection service or consult to certify actual satisfactory completion on each of the above-referenced stages of work, before any progress payment is due, as stated hereinabove, which satisfactory completion shall not be reasonably withheld by owner and/or its construction inspection service.

The entire amount of the agreed price under this contract has to be paid within 35 days after completion, as defined under California law.

6. Time for Commencement and Completion of Work.

The work shall commence within 10 calendar days after receipt of written notice from Owner to Contractor to proceed (Notice to Proceed), and the work shall be substantially completed within ___ calendar days thereafter. This schedule is subject to any unforeseen delays which are not in anyway, the fault of the Contractor, and which are caused by acts of god, stormy weather, Owner changes or Owner answers, and uncontrollable waiver of difficulties (all of which must be specifically recognized by Owner in writing). Time is of the essence to this Contract. The above-stated substantial completion schedule shall be substantially adhered to during the term of this Contract unless Owner and Contractor agree in writing that a schedule modification is appropriate.

The term "substantial completion" as used herein, shall be defined as completion of the work suitable to meet the requirements of the issuance of the Certificate of Occupancy or Temporary Certificate of Occupancy by the City of _____ and/or approval of the Owner if no Certificate of Occupancy is required for the improvement contemplated by this Agreement.

7. Liquidated Damages and Delay of Completion.

The Owner and Contractor agree in the event that the work, which is the subject of this Contract is not substantially completed as defined herein by the scheduled completion date following the Notice to Proceed, the amount by which Owner shall have been damaged although substantial will be difficult to fix. The Contractor and Owner therefore agree that no liquidated damages are appropriate and that the only remedy which Owner may have is for extension of time of completion and that no damages for delays shall be awarded.

8. Contractor's Duty.

Subject to and in accordance with the terms and provisions of this Contract, Contractor shall construct, equip and furnish for the Owner the within described work which is described and reasonably inferable from the drawings herein described (and made a part hereof) as fully and to the same extent as attached hereto. In connection therewith, Contractor shall provide and furnish all materials, supplies, appliances, equipment, fixtures, tools, implements and all other facilities and all labor, supervision, transportation, utilities, storage and all other services as and when required for and in connection with the construction, furnishing, or equipment of the within described work, pursuant to the Contract documents. The Contract documents shall mean this Contract, those certain drawings and plans provided to the Contractor, including the purported general notes affixed thereto, and as modified by any written change orders executed to this Contract by the Owner and by the Contractor.

9. Contractor's Performance.

Contractor covets that the work which is does pursuant to this Contract shall be in good and workmanlike and to the reasonable satisfaction of the Owner, and that all materials furnished and used in connection therewith shall be new. Contractor shall cause all the materials and other parts of the work to be readily available as and when required or daily _____ equipment of the work provided for herein.

Contractor shall provide competent supervision as to all phases of the work, including all of its subcontractors and suppliers, and Contractor shall cause the work to be performed in accordance with the drawings, plans and specifications incorporated in this Contract, and all things indicated are reasonably inferable therefrom. Contractor shall provide a schedule of the work to Owner prior to or upon commencement of the work. If requested by Owner, Contractor shall also prepare and furnish project manning charts for all key trades and schedules for the persons and delivery of all material, together with periodic updating thereof.

The subcontractors who are retained by the Contractor to work on this project are: _____, _____, _____.

10. Contractor's Lien Releases.

Upon satisfactory payment being made for any portion of the work performed, under applicable law, the Contractor shall refrain from any further payment being made, furnish to the Owner in full and unconditional relief from any claim or mechanic's lien pursuant to Section 3114 of the California Civil Code, for that portion of the work for which payment has been fully made.

11. Notice to Owner.

You, the homeowner (the "Buyer") have the right to require that your Contractor furnish you with a performance and payment bond or use a joint control approved by the Registrar of Contractors. You, the Buyer, may cancel this transaction at any time prior to midnight of the third business day (in the case of disaster repairs, seventh business day) after the day of this transaction. See the attached Notice of Cancellation form for an explanation of this right.

Owner hereby designates the following Builders Control Service _____, _____ and _____, to administer payments to the subcontractors and suppliers on this project.

12. Allowance.

From time to time after commencement of the performance of the work, Owner may prepare and deliver to Contractor written communications of instructions for utilization of any allowance items provided for hereinabove. Such allowance items include, as described above: plumbing fixtures (_____); tile material (_____); floor covering (_____); in the amounts specified. Said amounts are all applied to the guaranteed maximum cost of this project of _____. In the event that the costs of performing the work, included in the allowance items is less than the amounts set forth above, the guaranteed maximum price for this Contract of _____ shall be reduced the amount of the allowance of amounts not expended. Should the cost of performing said allowance work exceed the amounts set forth above, then the Owner shall pay the Contractor such actual costs, pursuant to the Owner's specific written instructions, and the guaranteed maximum amount of the Contract shall be increased to such extent.

13. Delay.

Contractor shall be responsible for timely completion of the project consistent with the time limits set forth for the work herein. However, Owner shall also be responsible to cooperate in good faith with the Contractor, and not to interfere with the Contractor's progress of the work. Owner understands that Owner must provide timely input and counsel to the Contractor regarding inquiries and directions to proceed where reasonably requested by the Contractor. Any delay which is solely caused by acts of god, owner interference, stormy weather, labor trouble, acts of public bodies and/or failure of Owner to make progress payments shall not be the responsibility of Contractor.

14. Extra Work.

Should the Owner direct any modifications or additions to the work covered by this Contract, and should the Owner and Contractor agree that there is extra work involved, the cost shall be added to the Contract price.

For the purpose of this "cost" is defined as a cost of extra subcontract work, labor and materials, plus 10% of such "costs" for overhead, and plus 7 1/2% of such "costs" for profit. Changes in the contract shall be evidenced by a writing signed by both parties. Contractor shall give adequate notice in advance when any "extra" work is in his/her view being required so that he/she and Owner can discuss the need for such work and the proper classification of such work, including appropriate cost adjustments. There will not be any unusual ground conditions encountered as to

the work. If there are unforeseen conditions and circumstances which the Contractor discovers during the course of demolition and/or construction of the work, then Owner shall receive timely notice of such and Contractor and Owner shall negotiate in good faith any appropriate changes or additions to the work necessitated by such unforeseen conditions.

15. Completion and Occupancy.

Owner agrees to sign and record an appropriate Notice of Completion within five business days after completion of the project, which completion shall be established by agreement in writing of the Owner and Contractor. If the work passes final inspection by the City of Los Angeles, but the Owner fails to report the Notice of Completion within the time period above stated, then Owner hereby appoints Contractor as Owner's agent to sign and record a Notice of Completion on behalf of Owner. Under no circumstances may Contractor bar occupancy of the work by the Owner.

16. Contractor's Duties and Status.

Contractor bears the relationship of an independent contractor with Owner, and has no fiduciary duty or other relationship of trust with the Owner. Contractor agrees with the Owner to furnish his/her best efforts to cooperate with the Owner in furthering and expediting completion of the work. Owner agrees to cooperate with Contractor, upon timely request, as to any and all inquiries and explanations regarding the requirements on the project. Also, Owner shall cure the cooperation of the Owner's architect and/or engineer with the progress of the work by the Contractor and such design professionals shall not be allowed by the Owner to interfere with the work by the Contractor. If the Owner requests that the work covered by the allowance be accomplished in such way that the costs will exceed the allowance, Contractor shall promptly comply with the Owner's request, provided that the Contractor first provides written notice to Owner that the Cost will exceed the allowance and that thereafter the Owner will pay for the additional costs. The parties agree that appropriate communications shall take place between Contractor and Owner to advance the Contractor's responsibility assumed under the contract. It is understood that timely communication and cooperation between Owner and Contractor are essential for timely completion of the work.

17. Damage to Work and Insurance.

Owner will procure at his/her own expense and before commencement of any work hereunder, fire insurance and other casualty insurance with course of construction, vandalism and malicious mischief clauses attached. Such insurance shall be in a sum at least equal to the contract price with loss, if any, payable to the owner and any beneficiary or deed of trust covering the property, which are met solely within the knowledge and concern of the Owner. Owner is to be named as an additional insured on the Contractor's general liability insurance. If the work is destroyed or damaged by an accident, disaster or calamity such as fire, storm, flood, landslide, subsidence or earthquake, or theft or vandalism, the work done by the Contractor in rebuilding or restoring such work shall be paid for by the Owner only if such involved extra work and the Contractor has no responsibility.

If the work is destroyed or damaged by an accident, disaster or calamity such as a fire, storm, flood, landslide, subsidence or earthquake or by theft, or vandalism any work done by Contractor in rebuilding or restoring the work shall be paid for y the Owner as extra work, only if such involves extra work and the Contractor has no responsibility for such events of destruction.

The Contractor will maintain in full force the workers compensation insurance policy and the a comprehensive general liability insurance policy in amounts not less than required by this Contract and less than $300,000. Contractor shall furnish Certificates of Insurance to Owner before commencing work showing that the Owner is added as an additional insured under such insurance, including the comprehensive general liability insurance. This failure of the Owner to demand delivery of such certificates shall not relieve Contractor of any obligation under this Contract.

18. Right to Stop Work.

Contractor shall have the right to stop work if and only if (i) any payment under this Contract shall not be timely made to Contractor under this Contract; (ii) contractor and owner have a disagreement regarding the project, which the contract in good faith believes to be irreconcilable, or (iii) owner substantially interferes with contractor's good faith and proper performance of work on the project.

19. Limitations.

No action arising from or related to the Contract, or performance thereof, shall be commenced by either party against the other more than five years after completion or cessation of the work under this contract. This provision does not limit, change or eliminate the otherwise applicable statutes of limitations available under California law, particularly those applicable to latent and patent defects.

20. Attorneys Fees.

If either party becomes involved in litigation arising out of this Contract, or the performance thereof, the Court in such litigation, or in a separate suit, shall award reasonable costs and expenses, including attorneys fees, to a party justly entitled thereto. In awarding attorneys fees, the Court will not be bound by any Court fee schedule; but shall, if it is in the interest of justice to do so, award the full amount of costs, expenses and attorneys fees paid or incurred in good faith.

21. Cleanup.

Upon completion of the work, Contractor shall remove debris and surplus material from Owner's property, and leave Owner's property in a neat and broom clean condition.

22. Taxes and Assessments.

Taxes and special assessments of all descriptions will be paid by the Owner.

23. Notice.

Any notice required or permitted under this Contract, shall be given by ordinary mail at the addresses contained in this Contract; but such addresses may be changed by written notice given by one party to the other, from time to time. After a notice is deposited in the mail, postage prepaid, it shall be deemed received in the ordinary course of time.

24. Prohibition of Assignments.

Contractor may not assign this contract or payment due under this Contract to any other party without the written consent of the Owner.

25. Incorporation of Section 7159 of the California Business and Professions Code.

Section 7159 of the California Business and Professions Code, as amended by AB 2190, effective January 1, 1992, and as reproduced in the last page of this form, is incorporated in this Contract.

26. Changes in the Work.

Any alteration or deviation from the Contract documents hereby identified for performing the work, involving extra costs of material or labor will be performed only upon written orders for same, signed by each of the Owners (George and Cecilia Calkins), and will become an extra charge over the guaranteed maximum sum of this Contract, only by Contractor following the procedures set forth in this Contract. All such change orders shall be in writing. Any such changes in the work, shall only be performed upon written communication by Contractor to Owner describing the changes, and upon the Owner's execution of change orders giving Contractor specific authority to proceed, setting forth, in detail, the nature of the requested change. Upon receipt by Owner of any executed change order, Contractor shall within five days furnish to Owner a statement in writing setting forth in detail, with suitable breakdown by trades and work classifications, the changes and the guaranteed maximum costs attributable to the changes set forth in said change order request, including any proposed adjustment in the scheduled completion date resulting from such change order requests. If Owner approves in writing such changes, the guaranteed maximum cost and schedule will be adjusted, as set forth in such written change order requests signed by the parties. Owner shall have the right to issue change orders deleting portions, or entire categories, of materials and services from the work, and to reduce the guaranteed maximum price of $50,000 by the amount of the materials and services attributable to such deletion (together with the prorata portion of the Contractor's profit and overhead).

27. Applications for Payment.

At least five calendar days before the date of any scheduled payment under this Contract, as hereinabove provided, Contractor shall provide to Owner an application for payment ("Application for Payment") in form and substance satisfactory to Owner. Each application for payment shall be for a sum specified hereinabove in this Contract (which provides for six payments upon completion of specified portions of the work, including after job completion). Each application for payment shall provide a specification of the exact work and materials provided by the Contractor, including an accounting of the cost and value of the work and materials provided. Title to all work, materials and equipment shall pass to Owner upon payment, and Contractor shall prepare and execute all documents necessary to effect and perfect such transfer of title.

In each application for payment, Contractor shall certify that such application for payment represents a reasonable statement of the actual costs payable to Contractor under the terms of this Contract, and shall also certify as follows:

> "There are no new mechanics or material liens outstanding at the date of this Application for Payment. All due and payable bills with respect to the work have been paid or are included in the amount requested in the current application. Except for such bills not paid, but so included, there is no known basis for the filing of any mechanic's or material liens on the work. Waivers from all subContractors and materialmen have been obtained in such form as to constitute an effective waiver of the lien under the laws of the State of California, to the extent payment made by Owner to Contractor."

Contractor shall furnish with each application for payment waivers of liens for itself and each of its subContractors and suppliers, and any such forms as required by Owner, Owner's title insurer, Owner's construction lender, or Owner's permanent lender for the project (or any portion thereof), in order to assure an effective waiver of mechanic's and material liens relating to the payment in compliance with the laws of the State of California. Contractor shall furnish any supplemental waivers of liens for itself and each of the subContractors and materialmen as may be reasonably required by the Owner, the Owner's title insurer, or lenders to the full extent of the payments made by the Owner.

On or about three calendar days after submission of each such application for payment, Owner shall make payment to Contractor in the appropriate amount, except the amounts as to which the Contractor has failed to make provision of appropriate supporting data and other documents, as hereinabove provided, including appropriate lien releases. The payment of any application for payment
by Contractor to Owner, including the final certificate for payment by Contractor to Owner, does not constitute a waiver of any claim that Owner may have for defective or inadequate workmanship or materials against the Contractor. Contractor agrees to timely pay all of his/her subcontractors and materialmen as to the work in order to prevent the occurrence of any liens upon the subject premises or property.

Owner has no obligation to pay any portion of the contract amount, pursuant to application for payment or otherwise, if Contractor is in default as to any of its obligations hereunder or otherwise is in default under any of the Contract provisions.

Owner reserves the right to make payment to Contractor and any subContractor by appropriate joint check.

28. Termination of Contract. If Contractor shall fail to commence and perform the work in accordance with the provisions of this contract, or shall fail to diligently prosecute the work to completion, in a diligent, efficient, timely and workmanlike, skillful and careful manner, or Contractor shall fail to timely make any payments to Subcontractors, materialmen or laborers, then Owner shall have the right, if Contractor shall not cure any such default after fourteen days written notice thereof, to:

(i) terminate the employment of Contractor hereunder;

(ii) take possession of and use all or any part of Contractor's materials, equipment, supplies or other property of any kind used by Contractor in performance of the work and to use such property in the completion of the work; or

(iii) complete the work in any manner the Owner deems desirable, including the engaging of the services of other parties therefor.

Owner hereby reserves the right to terminate this Agreement without regard to default or breach, and for convenience of the Owner, upon written notice to Contractor, effective immediately unless otherwise provided in said notice. In the event of any such termination, Owner shall promptly pay as the sole amount due the Contractor in connection with this project, all sums then due to Contractor for work actually performed and completed to the date of the termination (except retained sums which shall not be paid prior to 35 days following the date of termination).

29. Liens.

Contractor shall not voluntarily permit any laborers, materialmen, mechanics or other similar liens to be filed or otherwise imposed on any part of the work or the property on which the work is performed, provided that the specified payments are made by Owner to Contractor, or Owner is excused for not making such payment, in accordance with the terms of this contract. If any such lien is not discharged by Contractor forthwith, or the Contractor fails to file a bond in lieu thereof, Owner shall have the right to pay all sums necessary to obtain such releases and discharge, and then deduct all amounts so paid from the balance due the Contractor under this contract.

30. Title to Work.

Immediately upon performance of any part of the work, as between Contractor and Owner, title thereto shall vest in Owner; provided, however, that vesting of such title does not impose any obligations on Owner or relieve Contractor of any of its obligations hereunder.

Any provision hereof to the contrary, notwithstanding, Contractor shall observe, abide by and perform all of its obligations hereunder in accordance with all applicable laws, rules and regulations of all governmental authorities, having jurisdiction.

31. Contractor's Warranty.

Contractor represents and warrants that Contractor holds an active unencumbered Contractor's license, to perform the services included in this contract, as required by law, and that Contractor shall keep and maintain such license in good standing, and in full force and effect at all times while Contractor is performing the work under this contract.

Contractor represents that he/she is fully capable (as will be all of his/her workman, suppliers and subcontractors) to perform all aspects of the work described herein.

32. Defects.

Contractor shall reexecute any parts of the work that fail to conform with the requirements of this Contract, and the Contractor shall remedy any defects in the work, materials or workmanship, due to faulty materials or workmanship which appear within a period of one year from the final date of the work hereunder, and Contractor shall replace, repair or restore any parts of the work that are injured, or damaged by any such parts of the work that do not conform to the requirements of this Contract, or that are injured or damaged by any defects in the work. Contractor's warranty herein shall be in addition to and not in lieu of, any other remedies owner may have under this Contract, at law or in equity for defective workmanship by the Contractor.

33. Dispute Resolution.

All claims, disputes and other matters in question between Contractor and Owner arising out of or relating to the work of improvement herein under this Contract shall be first submitted to non-binding mediation in order for the parties to attempt to settle the matter, and failing to achieve settlement, all such disputes shall be decided by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association then existing, before an appropriate retired judge of the Los Angeles County Superior Court, as designated and chosen by the JAMS/Endispute organization, or by mutual agreement of the parties.

34. Performance and Payment Bonds.

It is understood by the parties that the Owner, at the Owner's sole expense, may obtain a performance bond assuring completion of the work without default by Contractor, and a payment bond assuring payment of all subContractors, materialmen and suppliers of the Contractor. Contractor understands that Owner may record said payment bond and file its contract with the Los Angeles County Recorder's Office pursuant to applicable provisions of California law.

35. Acknowledgment by Owner that They Have Received the Notice to Owner Specified by Section 7018.5 of the State Contractor's License Board.

The Owner acknowledges that it has received the Notice as specified by Section 7018.5 of the California Business and Professions Code. Included in that Notice is Owner's acknowledgement of complete text of Sections 70151, 70151.2, and 70159 of the California Business and Professions Code. In no event shall the payment schedule herein provide for Contractor to receive nor shall Contractor actually receive, payment in excess of 100% of the value of the work performed on the project at any time.

DATED: _____, 1996 By_____

DATED: _____, 1996 By_____
Owner

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Appendix H LEGAL ASPECTS OF CONSTRUCTION ADMINISTRATION

by George D. Calkins, Esq.
Cox, Castle & Nicholson, LLP

SUPPLEMENT REGARDING LEGAL ASPECTS OF CONSTRUCTION ADMINISTRATION

I. INTRODUCTION AND OVERVIEW

A. Objectives of Contract Administration.

The purpose of this discussion is to address some of the legal issues confronted on construction projects from the perspective of those working in the industry, insofar as that is possible. These materials are presented from the perspective of a general contractor. We will refer to an imaginary Company (a contractor) as we proceed in our discussion. The discussion will also address the concerns of subcontractors and suppliers.

It is helpful to review the objectives of construction administration from the perspective of those responsible for the project. Those objectives can be summarized as follows:

1. Generate appropriate project or development opportunities for the Company, consistent with its capabilities.

2. Define the fundamental goals and objectives of the Company and work cooperatively with all involved to timely and profitably complete the Company's projects.

3. Understand and implement the requirements and objectives for each construction project, to the best of the Company's ability, while at all times addressing and documenting significant issues which arise concerning the Company's ability to timely and profitably complete a project.

4. Ensure that the Company's subcontractors perform their work in a timely manner in accordance with the applicable construction schedules, agreements, plans and specifications.

5. Identify and resolve claims and disputes promptly when they arise, hopefully without the need for litigation, arbitration or other time consuming, risky and costly legal measures.

6. If a dispute must be litigated, insure that the Company will have the necessary records and evidence to effectively present its case, and prevail.

An appropriate approach to achieve these objectives is to implement an aggressive program of project administration, including an effort to do each of the following:

1. Understand, in detail, the contents of the relevant contract documents;

2. Make certain that all contract documents are properly completed and signed;

3. Follow established procedures for preparation and implementation of each of the contract documents (i.e., follow the rules for formation and completion of the contract requirements);

4. Avoid unwritten agreements, "side deals" and other informal practices which lead to misunderstandings and disputes; and

5. Be thoroughly familiar with and understand the subcontracts relating to the project, maintain solid communication with all the parties engaged in the project, and keep a well-documented file regarding the project.

In construction disputes, the single most common problem is the absence of contract documentation to support your position. In any construction dispute which goes to litigation, the party with the superior documentary record to support its position will be in a better position to win. Careful contract administration can save the Company thousands of dollars in unnecessary legal fees and discourage subcontractors, suppliers and other third parties from pursuing meritless claims and litigation.

B. When a Lawyer is Needed

As with most other things in life, there is a right time and wrong time to consult a lawyer. The following is a nonexclusive listing of criteria as to when the Company ought to consider consulting its lawyer, and when it shouldn't:

1. When the Company receives a communication from a lawyer indicating that he/she represents a party involved in one of the Company's projects, is frequently a time when the Company should consult its lawyer before proceeding.

2. If the Company is presented with documents appearing to be new, unusual or unforeseen contract forms, additions, modifications or change orders, then consultation with the Company's lawyer might be advised.

3. If the Company encounters conduct by another party on a project which appears to be quite inconsistent with its previous experience, and the circumstances carry a substantial risk factor for the Company, then consideration should be given to consulting the Company's lawyer.

4. If claims (in the several thousands of dollars) are made against the Company by anyone, consult the Company's lawyer.

5. If the Company believes it should consider terminating a contractor or pulling off of a project, because of circumstances or conduct which jeopardize a project or the Company's position, then consideration should be given to consulting the Company's lawyer.

6. If the Company confronts circumstances which tend to raise substantial doubt in management's mind as to whether the Company will receive payment for any portion of its work on a project, then the Company probably needs to consider its options, in consultation with its lawyer.

7. Day-to-day ups and downs in conduct of a project, which are not unusual, normally do not require the attention of the Company's lawyer.

8. If management runs into personality problems with specific representatives of another party on a project, consultation with the Company's lawyer is usually not indicated. Interpersonal relationship problems should not generally be misinterpreted as a legal difficulty.

9. If difficulties persist, after the Company has made repeated efforts to resolve a problem by informal consultation, then consideration should be given to asking the Company's lawyer to undertake an appropriate strategy to deal with the situation, particularly if there is a significant risk of a potential claim situation.

10. If a party takes some action to either place a lien on the project, stop the flow of construction funds, or contact the Company's surety or insurer, such circumstances usually require the involvement of the Company's lawyer.

11. Injuries or loss of property on a project, normally require consultation with the Company's lawyer (and insurer) at some point.

12. If there is financial instability (of any owner or subcontractor) or disputes persist impacting upon the potential profitability of the project for the Company, then consultation with the Company's lawyer normally is important in addressing the situation.

C. Goal - Maximize Legal Position

An important consideration with reference to the legal aspects of the Company's projects, is how at all times to maximize the Company's legal position.

II. LEGAL ASPECTS OF ESTIMATION AND BIDDING

A. Bids and Quotes By the Company and Its Subcontractors

The bid and negotiation process is often the beginning of the Company's involvement in a project (i) as a contractor or (ii) with its subcontractors.

Invitations to bid are frequently published in local construction industry trade papers. Bidding documents include the invitation (advertisement), instruction to bidders, bid forms, contract documents and addenda affecting the bidding documents. All of these documents could have legal implications and need to be examined and understood in that light.

Frequently, bid documents require that the bidder represent that it has read and understood the documents, visited the site and familiarized itself with the conditions that may affect the project. All of those representations have legal implications, should the Company or one of its subcontractors later determine that it was mislead by the plans and specifications, or that it got into a contract which proved unprofitable. Every representation and statement made by the Company during the bidding process could come back to haunt it. Accordingly, the approach to any bidding process should be carefully undertaken.

The instructions to bidders should be read very carefully by the Company and designated subcontractors from the standpoint that the instructions set out the rules with reference to conducting the bidding operation, and with reference to possible interpretation of the contract (once it is entered into by the successful bidder). Frequently, the instructions state that requests from bidders for interpretations or corrections in bidding documents should be addressed to a design professional who is designated to be the final arbiter in such matters. Instructions also normally state that there can be no substitution of material or equipment unless a written request is made within a specified number of days before receipt of bids. Usually, such a request must contain a complete description of the substitution so that the substituted equipment or material can be evaluated.

Furthermore, instructions quite typically require that the bidder give the design professional representing the owner the estimated cost for each major item of work in his/her bid, the work to be done by the bidder's personnel, the names of his/her subcontractors, and the names of the material and equipment suppliers within a set period of time. Such statements and representations can have significant legal representations later on.

The long and the short of it is that the Company should carefully approach the bidding process. The handling of the bidding process could create substantial business difficulties for the Company, which could have significant legal implications.

Not infrequently, the Company engages in a process of negotiation (in addition to or instead of bidding) in the formation of subcontracts. The success of contract negotiations, whether involving construction contracts or otherwise, depends upon many variables, most of which ultimately bear upon the relative strengths and weaknesses of the parties.

The basic goal in construction contract negotiations is an allocation of the risks between the parties. The ability to identify and appraise these risks can move the parties closer toward an equality of bargaining power, notwithstanding the above variables. Intelligent negotiation requires a thorough understanding of the basis of construction contracting. This basic principle can be reduced to several key issues which are invariably a part of every construction contract, including:

1. In determining which party should bear a particular risk, certain questions should be answered:

   a. Who is better able to recognize and assess the risk?

   b. Who is better able to control the risk?

   c. Who is better able to bear the consequences of the risk?

2. If the Company participates in a project as a potential subcontractor and provides an oral quote for a particular contract, it can have significant legal implications.

3. Before submitting its bid to the owner the Company must know (to a high level of certainty) what its costs will be to perform the work. To accomplish this, the Company solicits and receives bid proposals from subcontractors for certain assigned portions of the work and undertakes to estimate and perform other portions of the work itself. The Company should always strive to assure that a subcontractor's bid proposal is in fact a definite offer to perform. This bid will become an enforceable contract if the bid is accepted, as opposed to a naked price quotation which courts have frequently viewed as preliminary negotiations.

Without contrary language appearing in the bid or invitation to bid (or some other enforceable type of reliance by the contractor upon a subcontractor's bid) the subcontractor may, under traditional contract formation rules, withdraw its bid at any time before a communication of acceptance by the contractor. The amount of the subcontractor's proposal, the scope of his/her work and other conditions to which the subcontractor commits, are critically important. Therefore, when the Company receives and acts upon subcontractor quotations and proposals, it is in a predicament: It has no need or desire to accept the proposal until it knows whether its own bid is accepted by the owner. This time lapse between submission and owner acceptance or nonacceptance creates the risk, under traditional contract law principles, that the subcontractor will withdraw its bid in the interim.

In an effort to deal with this risk and avoid disputes when a subcontractor withdraws its bid in such a manner, contractors frequently require subcontractor offers to be firm or irrevocable for a definite period of time after submittal.

A firm, irrevocable offer by a subcontractor has been found by courts to be a commitment which is contractual in nature and legally enforceable as such. A subcontractor who fails to perform or honor such a bid may be liable to the contractor for resulting damages incurred by the contractor.

B. When Is the Contractor Legally Bound?

Normally, when the Company receives a bid from a subcontractor, the subcontractor is legally bound to perform the work as indicated in the bid documents, upon acceptance of the bid pursuant to its procedures. Reliance by the Company upon the subcontractor's bid, in the form of acceptance or some other conduct, is the point at which the subcontractor normally becomes legally bound. Acceptance of the subcontractor's bid or any other form of reliance by the Company, is the point at which the subcontractor's legal obligations under the contract become fixed.

It is extremely important, therefore, that the Company know from the outset what the bidding and negotiation rules are, both formal and informal, and who will be conducting the bidding process for the awarding authority. Appropriate business determinations should be made as to whether the Company should bid the project. Risky contract circumstances should be clearly identified and understood. To be aware of the potential problems, the Company should analyze any potential contract, during the bid estimation stage to determine whether:

1. The time frame for performance of the construction is reasonable;

2. Time extensions are specified in the contract for excusable delays;

3. Time extension clauses are restricted to time or also provide for compensation;

4. No damages for delay provisions exist;

5. Scheduling and milestone requirements are reasonable;

6. Specifications appear to be adequately prepared so that reasonable bids can be prepared and Construction undertaken based thereon;

7. Design appears to be adequate;

8. The guarantee provisions are reasonable; and

9. The owner bears the risk of sub-surface conditions.

As a part of such a review, the Company should also determine what risk allocation or equitable adjustment clauses appear in the contract which are for the Company's benefit, and what procedures for their enforcement exist.

Understanding of the current legal interpretations given to key clauses is also important. But exceptions always exist in enforcement of "no damages for delay" clauses, and determination of what types of work are subject to a "change order" clause.

C. Mistakes and Miscommunications In the Bid Process

Under some circumstances, a mistake in preparing a subcontractor's bid can result in the subcontractor being relieved of its obligations under a contract. A unilateral mistake, or one having to do with an error in judgment, is less likely to result in the subcontractor being relieved of its responsibilities once a bid is accepted and a contract formed with the awarding authority.

The right to terminate the contract is available to the subcontractor where there are instances of mutual mistake; that is, both the subcontractor and the Company are mistaken on some point. Such relief is also available for some forms of unilateral mistake.

It has been the law in California for quite some time that a bidder can withdraw his/her bid for a unilateral clerical mistake which is not the result of neglect by the subcontractor, where prompt notice was given to the awarding authority and the awarding authority suffered no damage, despite inclusion in the invitation to bid of a statement that bidders "will not be released on account of errors". Elsinore Union Elementary School Dist. v. Kastorff, (1960), 54 Cal.2d 380, 388-389.

A unilateral mistake by the Company, in most instances, cannot be the basis for a change in the contract for the benefit of the Company. Mistakes in reading plans and specifications are normally not the basis for relieving subcontractors from contract responsibilities. California law also provides that no change shall be made in a bid because of a mistake.

D. Prudent Practices In Taking Subcontractor Quotes

Subcontractor quotes should be conducted pursuant to applicable law and the bid specifications. Subcontractor quotes should be memorialized in writing. A complete file of the circumstances surrounding receipt of a quote should be kept. The name of the party representing the subcontractor providing the quote should be noted as well as the date and time of the conversation. Quotes should be accepted only from subcontractors with whom the Company is familiar and as to whom there exists a responsible track record. As always, the Company should work very hard to maintain an accurate file of its subcontractor quote discussions, so that appropriate reference later on can be made, should the need arise.

III. CONTRACT DOCUMENTS

A. What Is the "Contract", And What Isn't?

The orderly performance of complex construction contracts requires that fair and practical methods of interpretation be available. This is necessary so that construction can proceed without undue hardship upon the participants.

All of the elements which are included in the construction contract are pretty well known in the construction industry as the "contract documents." According to the American Institute of Architects, the contract documents consist of the owner-contractor agreement, the conditions of the contract, the drawings, specifications, all addenda issued prior to execution and all modifications issued after execution of the contract. These materials comprise the complete "Contract" for the construction of a project.

The construction contract sets out the rights, responsibilities, relationships and liabilities of the parties involved. The rules of interpretation of contracts, generally, apply to construction contracts requiring that effect be given to the intention of the parties as gathered from the plain reading of the entire contract, with ambiguities normally construed against the drafter. Clarity in drafting is a primary tool by which to avoid litigation and disputes in connection with a contract.

A contractor's responsibility and liability is fixed by the terms of the contract. He/she is obligated to perform according to those terms. The contractor cannot be burdened with obligations to perform for which he/she did not originally contract. Questions obviously arise in great numbers as to what the contractor agreed to do by his/her contract and what kinds of things are covered under the provisions which call for changes in the work. The change order provision is an attempt to incorporate a flexible provision in a fixed agreement to take into consideration unforeseen conditions which are likely to present themselves during the course of work.

Field authorizations, letters, memoranda, communications from the owner's engineer, field notes, diaries and other such documents, normally are not considered a part of the contract documents, unless specifically incorporated within the construction contract itself. (In most government contracts, the bid package, invitation to bidders, the bid, the contract, government regulations regarding labor and equal employment opportunity, the standard specifications and the plans are normally incorporated in the "contract.")

Detailed specifications, the most commonly used, describe the materials, dimensions and locations of all elements of the final product. Those specifications attempt to represent the completed construction project in such detail that the owner, contractor, architect and other interested parties all agree on the exact physical properties of the final product, e.g., the exact formula to be followed in mixing concrete, specific equipment to be utilized for the air conditioning system, and so on.

Outline specifications, as opposed to detailed specifications, are used by contractors to meet the needs of the customer, usually an industrial owner, who needs warehouse or manufacturing facilities or a combination of both, and would like to handle the entire program through a single contractor who will design and build the facility on a cost-plus basis, or sometimes

with a guaranteed maximum price. The outline specifications merely designate broad features, such as major construction or types of walls, type of electrical circuitry, and the type of air conditioning.

B. Specific Examples Of Whats Or Is Not Incorporated In The Contract

Incorporated within every contract and subcontract, by operation of law, is an implied covenant of good faith and fair dealing. Gray v. Bekins, (1921), 186 Cal 389, 394-395. That covenant requires that neither party to the contract do anything which would hinder or interfere with the other party's right to obtain the benefits of the contract. The implied covenant of good faith and fair dealing is not a frequently used device in government work, but could be more frequently utilized where agency representatives are acting in an arbitrary and unreasonable fashion.

If the Company is to "make its case" of being treated unfairly by a subcontractor, the Company will do so by introducing correspondence and other documents, which support the proposition that the subcontractor is behaving in bad faith and violating the implied covenant of good faith and fair dealing. A "record" must be made of the conduct to succeed.

One of the first things the Company should do in reviewing a subcontract document is to check it for completeness. Check the drawings against the drawing index. Check the specifications against the specifications index. Before submitting a bid, ascertain that all addenda have been received. On the occasion of signing a contract, the Company should follow the procedure generally accepted and have all the contract documents executed in triplicate. Thereafter, the Company should attempt to formalize all modifications to the contract by use of written change orders. Following all of these procedures will eliminate the necessity for interpretation of what constitutes the contract documents on any particular project.

A common practice among general contractors and owners, which can and does occasionally lead to disastrous results, is the disassembling of the drawings and specifications for distribution to subcontractors (such as electrical and mechanical). Architects and engineers expect that all of the subcontractors will have reference to all of the drawings and specifications and be somewhat conversant with them. Sometimes, information very important to the preparation of the subcontractor's bid is on the architectural or structural drawings which they have not seen. While the Company normally does not use all that many subcontractors on its typical projects, the Company should make an effort, as a part of its plan to coordinate the work by subcontractors, to make certain that all subcontractors have a complete set of the plans and specifications available for any project.

C. Change Orders And Field Authorizations

Field authorizations, not executed by authorized officers of both the awarding authority and the Company, are frequently ineffective documents. Yet, they can be construed as admissions against the Company where field authorizations are issued to subcontractors, who rely thereon and perform services. Field authorizations should be carefully utilized.

Probably the most frequently invoked clause in the standard form of construction contract is the change order clause. This clause basically provides that the owner may order changes in the work, after the basic contract is executed and demand specific performance without invalidating the contract. This clause permits a job to continue toward completion under the basic contract while the owner and contractor deal with new ideas or changed conditions. The changes may consist of additions or deletions within the general scope of the work. The clause also provides for adjustment of contract time and price based on the effects of the changes ordered. The change order is generally required to be in writing and must be signed by the owner and/or the architect.

Construction contracts often involve changes within the general scope of the work:

(1) In the specifications;

(2) In the method or manner of performance of the work;

(3) In the government-furnished facilities, equipment, material, services or site; and

(4) Directing acceleration in performance of the work.

In private work projects, changes most frequently arise over:

(1) Changed or concealed conditions on the job, such as work below ground;

(2) Increased costs due to changed conditions;

(3) Delays, stop work orders, etc.; and

(4) Extensions of time.

The most important factor in successfully negotiating a change order is to have a clear and complete working knowledge and understanding of all resulting contract requirements with reference to the scope of work and methods of performance.

Extra work is the most common type of change order. As used in connection with a construction contract, it means work of a character arising outside, and entirely independent of, the contract--something not required in its performance, not contemplated by the parties and not controlled by the contract. Frank T. Hickey, Inc. v. L.A.J.C. Council (1954) 128 Cal.App. 676, 683.

Where extras are of a different character from the work called for in the contract and no price is agreed upon for the extra work, the contractor is entitled to recover the entire "reasonable value" of the extra work. The extra work ordered by the owner constitutes a change to the contract under the scope of the work provisions of the contract. Also, the arbitrary deletion of a major portion of work by the owner may entitle the contractor to his/her "loss of profits" in connection with the deleted work.

A contractor, who acting reasonably, is misled by incorrect plans and specifications issued by the owner during the bid-process and who as a result, submits a bid which is lower than he/she would otherwise have made, may recover damages for work necessitated by the incorrect plans and specifications.

Another type of change commonly encountered by contractors is a demand on behalf of the owner that the contractor perform the work by a method different from that specified in the contract or, if no method is specified in the contract, different than that planned by the contractor in bidding the project. This constitutes a change to the contract for which the contractor may be entitled to recover the "reasonable value" of the extra costs attributable to such change. The theory of this recovery is the same as extra work recovery discussed above.

"Constructive changes" broadly encompass all changes to the contract where the owner refuses to acknowledge the change and therefore also refuses to issue a formal change order. For example, the law is well established that the owner's unreasonable action, abusive discretion, overly strict interpretation of the contract, or erroneous interpretation of the contract may constitute a "constructive change" for which the contractor is entitled to extra compensation.

Most construction contracts contain a notice requirement to the effect that, as a condition precedent to the contractor's right to recover on any claim against the owner, the contractor must give prior written notice to the owner of the claim within a designated period time after the contractor learns of the facts giving rise to the claim. Such notice provisions are generally applicable to claims for extra compensation due to changes to the contracts. Inexcusable failure of the contractor to give the requisite written notice of claim may be asserted by the owner in certain cases as a bar to the claim. It is therefore strongly recommended that the Company routinely give the awarding authority or owner written notice of claim or potential claim immediately upon becoming aware of factual circumstances which may constitute the basis for a claim of extra compensation due to a change in the contract.

The notice provisions of a contract quite often purport to impose upon the contractor an impossible burden of including in the notice of claim infinite details as to the factual basis and amount of the claim. It is often impossible for the contractor to provide those factual details to the owner within the time period designated by the notice of the claim requirements. The courts have therefore held that substantial compliance with these notice requirements is adequate. Strict

compliance with such written notice requirements will not be required. There are certain exceptions to this rule, having to do with the actual knowledge of the contractor, the contractor's breach of contract, and conduct by the contractor constituting a waiver of the substantial compliance doctrine. However, failure to give notice may not be imposed as a bar to a change order where it is shown that the awarding authority is not prejudiced by the failure to give notice.

It is sometimes impractical to await the conclusion of the change order negotiations prior to commencement of the extra work involved in the change to the contract. Therefore, as an alternative to strict compliance with the written change order requirements, the contractor prior to commencing extra work, should insist upon a written directive from the owner to proceed with the extra work. Also, prior to or simultaneously with commencement of the extra work, the contractor should give the owner written notice of the claim for extra compensation in connection with the extra work. The contractor's written notice of claim should also include a confirmation of the owner's agreement to waive the written change order requirements of the contract. In this manner, the owner will be deemed to have waived the written change order requirements of the contract, and the contractor's extra work claim will be preserved for a later pursuit against the owner.

The written change order provisions of a contract may be waived by the owner, if a course of conduct on the project is adopted between the owner and the contractor inconsistent with the owner's reliance upon a strict compliance with such written change order requirements. Howard J. White, Inc. v. Varian Assoc., (1960), 178 Cal.App.2d 348, 353.

California law is well settled that a contractor is entitled to recover the entire reasonable value of extra work performed for the owner, where the extras are of a different character from contract work and no price is agreed upon for the extra work in the contract. Such major items recoverable under an extra work claim include direct extra costs, including labor, equipment, materials, insurance premiums, bond premiums and direct overhead. In addition, indirect extra costs, including home office overhead are sometimes recoverable in the absence of a specific contractual provision to the contrary. In the absence of a specific contractual provision to the contrary, the contractor is also entitled to recover from the owner a reasonable percentage markup for profit attributable to the extra work claim. Finally, deletion of a major portion of the work by the owner may entitle the contractor to recover his/her "loss of profits" in connection with the deleted work.

If a change order is in an item of work covered by a contract unit price, and such change does not involve a substantial change in the character of the work as that shown on the plans or included in the specifications, an adjustment in payment will be made in accordance with an agreement between the contractor and the Owner. If they cannot agree, the contractor shall proceed on the basis of extra work based upon the actual costs incurred, and a specified provision with percentages as markup for all overhead.

Frequently a contractor will sustain consequential damages and impact costs as a result of contract changes by the owner. These damages are in addition to the extra compensation normally paid to the contractor under the change order. If the owner demands that the contractor accelerate his/her work because of changes to the contract, or the wrongful refusal of the owner to grant extensions of time because of excusable delays in connection with the changes to the contract, such circumstances may entitle the contractor to recover from the owner the extra costs attributable to the acceleration. Furthermore, a contract change order by the owner may have the effect of severely delaying, disrupting and hindering the operations and performance of the contractor on the project, entitling the contractor to recover from the owner the extra costs and damages approximately caused by the delay, disruption and hindrance. The delay, disruption and hindrance costs and damages can include equipment, labor, labor
escalation, material escalation, extended direct and indirect overhead, extended insurance premiums, interest on retention, extended maintenance costs, consequential inclement weather damages, and other items. Moreover, a change may lose efficiency for the contractor, which itself may be compensable in the form of extra costs and damages attributable to the loss of time and efficiency.

D. Shop Drawings

The Company may encounter circumstances where shop drawings are used with some frequency on a project. Shop drawings are most normally used on building projects with reference to construction activities concerning construction of a structure of the building. Shop drawings constitute a contractor's recitation to the owner and the owner's architect of the contractor's understanding of what is to be built. Shop drawings are a checking device by which the interpretation on the plans by the subcontractor or contractor are reviewed by the owner and the architect.

IV. CONTRACT LEGAL ISSUES FOR CONTRACTORS

A. What Parts Of The "Contract Are Given Priority Over Other Parts?

There is no clear rule that can be safely relied upon to determine which of the contract documents shall take priority in case of conflict or ambiguity within or among the documents. Often the subject is resolved by an appropriate position being derived from the general conditions, standard of specifications and/or other outlined specifications for conduct of the work.

As a matter of custom, but not invariably, architects who provide a specific solution for resolution of conflict in their documents, prefer to have the specifications govern rather than the drawings. Some architects provide that the most stringent or most costly, condition would govern.

In the complete absence of a precedence clause, the architect could settle this issue by written interpretation in accordance with the procedures set forth and the general conditions of a contract.

Many of the inconsistencies, ambiguities and omissions in the plans and specifications are discovered by estimators of the general contractor, various subcontractors and suppliers. The contractor is required by the general conditions to report any errors which he/she may discover, although he/she will not be responsible for damages resulting from such errors. During the bidding period, however, he/she is not yet legally bound to the requirements of the general conditions. Accordingly, a contractor's motivation in reporting errors is to obtain more accurate bidding information.

Of serious potential concern are areas where inconsistencies are discovered during the construction period. Often the area of concern will become apparent during the preparation of shop drawings or in the field layout of dimensions. Any additional drawings or specification which will have to be issued at this time to clarify such problems will be considered as modifications to the contract and will often give rise to additional work charges to the owner. A contractor has the duty to seek clarification of clear ambiguities, without which he/she is not entitled to the benefit of the rule that ambiguities are to be resolved against the drafter.

Most contract provisions which are typed and not part of the forms, are in most instances given precedence over the boilerplate form portions of the contract. In short, very special conditions written by the awarding authority with reference to a specific project, are given precedence and priority over the printed forms of standard specifications, such as the Green Book.

"What kind of information belongs on the drawings" and "What should be in the specifications?" Are questions which frequently arise. As a general rule, information most effectively or most easily conveyed in graphic or diagram form should be on the drawings, while material more efficiently or conveniently transmitted by words, should be in the specifications. Drawings are very useful for transmitting data relating to the arrangement, location, dimensions, and interrelationships, while specifications are more suitable for describing quality, gauges, standards, guarantees, procedures and manufacturers' names.

A general concept pretty well recognized among building contractors is that the general contractor shall be solely responsible for all construction procedures and for coordinating all

portions of the work under the contract. He/she is also responsible for maintaining and supervising all safety precautions and programs. Drawings and specifications prepared under the latest state of the art will not violate that principle.

B. Ambiguity - Whose Problem?

Where a contract provision written by one of the parties is ambiguous, it normally will be resolved against the party who drafted it. (A major exception to this is contracts drafted by governmental entities. Such contracts are not interpreted by specific statutory requirements against the government entity who drafted it.) In its practical application, the general rule that ambiguous contracts are interpreted against their drafter, means that a contractor may rely upon his/her interpretation of an ambiguous provision if his/her interpretation is reasonable, he/she did not participate in the drafting of the particular contract clause and the clause is not so obviously or patently ambiguous as to have imposed on the contractor a duty to seek clarification.

A contractor has the duty to seek clarification of patent ambiguities, failing which he/she is not entitled to the benefit of the rule that ambiguities are to be resolved against the drafter.

The Parol Evidence Rule is a substantive rule of contract interpretation. It provides that where two parties have reduced their agreement to a writing, which sets forth their complete agreement, all prior negotiations and understandings whether written or oral are merged into the contract and cannot be used to vary, contradict or add to the terms of the contract. The Parol Evidence Rule does not, however, have any application to subsequent agreements or modifications of the contract. Also, there are substantial exceptions to the rule, which indicate that the parties may submit to the court evidence of their intentions and understandings at the time they entered into the contract.

C. Representatives Of The Company Should Be Aware of What's In the Contracts They Are Signing And Use The Contracts To Their Maximum Benefit

Not much legal insight or analysis is required to support the conclusion that the Company's project managers should be thoroughly familiar with all contract documents, and be prepared to engage representatives of the owner or awarding authority in discussions regarding contract interpretation, based upon that detailed background knowledge. An understanding of the contract should be undertaken as soon as possible, certainly before the first job or project meeting.

D. Scope Of Work Provisions

Particular attention should be given at all times, particularly during bidding and during contract administration, to what the scope of the work is under the agreement. This is a principle which need not be restated.

The importance of this principle from a legal standpoint, has to do with the contractor's reaction to extra work requests where contract additions or deletions substantially impact upon the scope of work of the project.

Normally a contractor bids a job on the assumption that for the bid price he/she will perform only the work called for by the contract. If additional work is added, he/she expects to be paid a sum in addition to his/her bid price, regardless of whether the additional work is due to the architect's error, the owner's oversight, or a desire to change and improve the project.

It is not uncommon for the owner to decide during construction of a project that he/she wishes to add features not included in the original drawings and specifications or decide to delete items from the drawings. If the contract reserves the right to the owner to make such changes and if the magnitude of
the changes is not excessive (i.e., does not exceed the scope of the work) the contractor will be obligated to comply with the change request. If the change is major, the contractor may contend that the scope of the change is beyond what could have been contemplated by the parties at the time the contract was signed, thus excusing him from the performance of the requested extras.

Even if the contractor is required to comply with the change, the amount by which the contract price is to be increased or reduced, as a result of the change, may be disputed.

If a dispute occurs, either over price or whether the work is extra, the parties first have an obligation to bargain in good faith. In many instances a contractor will elect to proceed with the work under protest after taking into account the extent of the claimed extra and the consequences of not proceeding. If the dispute involves some aspect of the work that could not be performed later, such as a request to wrap conduit before placing underground, the alternative to proceeding under protest may be to shut down the job. That is a significant and difficult decision which must be carefully considered.

If owner-requested changes are of such a magnitude as to change the scope of the work, the awarding authority may be considered to have abandoned the original contract. In such a situation the contractor will be entitled to recover the reasonable value of the work performed in a civil action. Excessive change orders may also constitute a breach of contract.

E. Time Extensions- Delay.

Most public and private construction contract disputes touch on the issue of delay. It is even an issue in disputes centering on injury or extra work claims. Causes of delay are numerous and may be the fault of the contractor, the awarding authority, both parties, or neither of them. When delays are caused by natural conditions over which neither party has control, such as the weather, labor relations problems and the like, neither party is at fault. The contractor is at fault when delay is due to the failure to order materials on time, failure to make timely submittals of equipment to be used on the project, inadequate coordination of subcontractors, and inadequate staffing of the job. Among delays caused by the awarding authority are failure to give prompt inspection, delay in processing of submittals, ordering extra work that delays the job, delay in processing extra work orders, and delay in furnishing access to the job site.

Construction delays are frequently injurious to all parties. Injury to the contractor includes direct job expenses, indirect costs (such as office expenses, salaries of home office personnel and the like) and adverse impacts on profitability of the job for the contractor. Frequently damages for delay to a awarding authority are very difficult to measure. The standard procedure is to determine damages to be awarded to the awarding authority by application of a "liquidated damages clause".

When delay occurs, it is usually due to a combination of factors. Part of the delay may be due to the fault of the contractor, part to the awarding authority, and part to weather, strikes or other events that are not the direct responsibility of either party. Thus, there is a problem of apportionment of damages for delay. Another part of the problem is determining the amount by which the delay in one portion of the job contributed to the delay in the completion of the entire project. For example, the contractor may claim the job was delayed by the architects failure to make a prompt selection of colors. Architects, on the other hand, can argue that the delay in selecting colors did not prevent the contractor from installing the roof.

One way to approach this type of problem is to determine whether the item of work is critical to the progress of the project. For example, installation of anchor bolts may be a prerequisite to pouring of a concrete slab. The slab must be poured before the job can proceed. Thus, a delay centering on anchor bolts worth a few cents a piece can stop a project worth millions of dollars. On the other hand, installation of the major component might not be very critical to the project's completion. For example, a delay of 30 days (not due to rain) in installing a roof might not interfere with any other trade and thus might not delay completion.

Given the supposition that a particular item of work is not on the critical path, accumulation of delay for a number of such items is bound to affect the job's organization and efficiency, and thus, ultimately delay completion of the entire project. If damages for delay are liquidated, calculation of the amount is eased. It is then necessary to specify the day on which the project is to be completed, calculate the total number of days of delay, minus the number of days for which the contractor is excused for delay by rain, and other excusable reasons, and finally multiply the remaining days by the liquidated damages figure.

The typical construction contract contains a provision that if the contractor is delayed by rain, and other excusable events he/she will be entitled to an extension of time, if he/she files a request within a certain number of days after commencement of the delay. The courts have held that if delay is in part caused by the awarding authority, the contractor is entitled to an extension of time even if he/she fails to request the extension in writing.

There is a division of legal authority in this state as to whether liquidated damages may be apportioned when the delay is caused by both the contractor and the awarding authority. The only California Supreme Court case on the issue stated, in language which was not material to the decision, that a awarding authority is precluded from claiming liquidated damages when it caused a part of the delay, even though the contractor may have caused most of the delay. Yet, there is a lower court decision which indicated that liquidated damages may be apportioned and distinguishes the earlier cases not allowing apportionment as involving those circumstances where there was not a contractual provision for extension of time and those circumstances dealing with private contracts.

F. Interpretation And Reconciliation of Contract Provisions.

There are certain principles of contract interpretation which are of note. Ambiguous provisions are interpreted against the drafter, except when the drafter is a public entity.

A basic rule of contract interpretation is that contracts are to be construed in accordance with the objective intent of the parties. The objective, as opposed to subjective intent, is that intent which one would infer from reading the contract. Subjective intent is the true intent or actual state of mind of the party who drafted the particular contract provisions.

Courts frequently rely on various miscellaneous rules of contract interpretation. In many instances such rules can be found to support several different and inconsistent results. For this reason, it is often said that courts first determine the result and then determine the rule of interpretation which supports it. Some of the miscellaneous rules frequently referred to in construction cases are:

1. Reasonable logical interpretation.

2. Normal meaning of words.

3. Look for the whole agreement, and not just parts of it.

4. Look for the order of precedence of a contract, and find those provisions of the contract which are given clear preference over others, such as specifically typed provisions over printed provisions.

5. Look for the principal purpose of the contract and follow that purpose.

6. Look for the usual custom and usage in the particular trade in question.

7. Examine what the course of dealing has been between the contractor and the awarding authority in the past on the issue.

G. Termination And Quitting The Job.

Termination from a project is a very difficult decision. It is one invariably based upon a calculation of what the impact of your decision will be when continuing with the project would be unfair or impossible. Invariably, the awarding authority will accuse the Company of breaching the contract, and will seek damages in the millions of dollars.

Several circumstances could result in a conclusion by a contractor that he/she should not proceed. One such circumstance has to do with a situation in which the specifications are said to be defective when they called for performance which is not possible.

Actual impossibility exists when the contract cannot be performed according to the specifications by the contractor or anyone else, because the specifications are erroneous or because performance requirements cannot be achieved, or because requirements, although conceivably attainable, cannot be attained without going beyond the existing state of the art. Aside from actual impossibility there is a practical impossibility, which exists when the contract requirements are impractical "because of extreme and unreasonable difficulty or expense in meeting them." Practical impossibility exists when: (1) the work is not possible within the basic contract objective contemplated by the parties; and (2) the cost and difficulty of performing the work renders completion commercially senseless.

When performance is impossible, the risk of impossibility is allocated to one of the parties in accordance with the various rules designed to impose the risk on the party which assumed that risk, either expressly or otherwise. In some contracts, the risk of impossibility is expressly allocated to one of the parties. As a general rule, the risk is allocated to the owner unless some special circumstance indicates that the risk should be allocated to the contractor. The risk may be allocated to the contractor where it is obvious, where the contractor warrants his/her ability to achieve a particular performance requirement, where the contractor had superior knowledge respecting the possibility of performance, or where the impossibility resulted from a shop design prepared by the contractor.

If the risk of impossibility is allocated to the owner, the contractor is entitled to recover the fair value of the services performed prior to the termination of work, but is limited to a ratable portion of the contract price. That is one situation in which termination of the contract by the contractor is permissible.

One of the most important implied provisions in a contract is the warranty that the project can be satisfactorily completed by following the specifications. Where that proves not to be true, the contractor may be justified in terminating.

There are provisions implied by law in a contract which are "indispensable to effectuate the intention of the parties" arising from the language of the contract and the circumstances under which it was made. The intent of the contract must be obtained from the entire document, including consideration of its subject matter and the purpose of its execution. The circumstances of the parties when they made the contract, must prevail over the recitals therein, unless the intent so gathered runs counter to the plain sense of the words in the agreement.

In every building contract, which contains no express covenants on the subject, there are also implied covenants to the affect that the contractor shall be permitted to proceed with the construction of the project in accordance with the other terms of the contract, without interference by the owner. Such terms are necessarily implied from the very nature of the contract. A failure to observe them not consented to by the contractor, constitutes a breach of the contract on the part of the owner, justifying termination by the contractor. The foregoing circumstances arising from impossible to perform conditions and breach of implied covenants of cooperation. Notwithstanding such, a decision to terminate a contract by the contractor is one which should not be taken lightly.

When a owner orders a contractor to proceed with work that the contractor claims is not included in the contract price, the contractor has a choice of abandoning the job, rescinding the contract and suing for damages or proceeding under protest and later filing suit to recover for the cost of extra work. A contractor can proceed under protest and not waive its claim for extra work compensation. When the contract documents require a written protest specifying in detail the work performed and the resulting cost, a protest letter that fails to comply with the contract requirements is ineffective.

Related to the performance under the protest theory is the theory of economic duress which is possibly subject to the doctrine of government immunity. Although no case has been found where the theory has been successfully applied in a construction case, it may be useful to keep that theory in mind, if a particularly difficult situation is confronted. Practically speaking, performance under protest is normally preferred over termination of the contract.

If circumstances become very difficult, it is always a very good idea to have a documentary record of the efforts to correct the situation and warnings to the owner.

In California, the failure of the awarding authority or owner to make progress payments under the contract to the contractor will entitle the contractor to rescind the contract unless the failure is only a minor deviation from the terms of the contract.

In determining whether the contractor would be justified in ceasing work and shutting down the job, consideration must be given to whether the owner or awarding authority is justified under the contract in ordering the contractor to do the work without additional compensation and, if not, whether the order constitutes a breach of contract sufficiently material to excuse further performance by the contractor. While the general rule is that a material breach of contract on one side excuses further performance on the other side, there is very little legal authority to guide one in distinguishing between a material breach and a minor breach. The safest course appears to be that when in doubt, proceed under protest, unless the owner's alleged breach is so material that to follow the owner's instructions would risk financial disaster to the contractor.

One case has held that, under the circumstances there, the contractor was justified in refusing to proceed if the changes are of such great magnitude. Otherwise, the contractor must perform and obtain subsequent judicial determination regarding his/her damages. If the changes are of great magnitude, as requested by the awarding authority, the contractor is obligated to negotiate in good faith for a satisfactory price and, having done so, is not required to continue performance of the basic contract when there is no agreement.

Similarly, when a subcontractor fails to adequately perform, the Company should make every effort to document its difficulties with the subcontractor, including providing substantial compliance with the notice requirements under the provisions of the subcontract. The subcontractor provisions regarding termination should be followed very closely, and only after substantial breach of a subcontract, should the Company elect to terminate a subcontractor.

H. Keeping An Accurate Job File Is Very Important To Successful Administration Of A Project

In order to maximize the Company's rights, a complete and accurate job file must be maintained. Appropriate diaries must be kept by the appropriate employees, and frequent communication should be engaged in with the owner where difficulties arise. When difficulties arise the communication should begin in a timely fashion, both orally and in writing. Any arrangements reached with the owner or awarding authority should be immediately documented in writing, if by no other means than a letter directed to the awarding authority's representative.

Efforts to keep in contact with the owner's representatives, including outside engineers, and to document that contact in writing, may assist the Company in obtaining payment for its services, at some later date. Efforts to completely document the file, at an early date, may prevent the need for substantial expenditures of money to prove-up the Company's position after the fact.

I. It Is Important That The Company Understand The Awarding Authority's Application Of The Contract Provisions And Where Appropriate Challenge Misapplication Of the Contract Provisions By The Awarding Authority.

In keeping with the recommendation that the Company remain aware of the contract provisions, project managers should work to understand the awarding authority's interpretation of the contract documents. Project Managers should also be sure to document misapplication of the contract provisions by the awarding authority, so that those misapplications can be addressed by informal negotiation. If an awarding authority has a misunderstanding of the 25 Percent rule, or if it disagrees regarding time delays, an immediate effort should be made to document those difficulties and an effort should also be made to resolve them by informal negotiation, protest and/or documentation of the dispute. Efforts to mediate differences of opinion should be made, including utilization of the American Arbitration Mediation procedures, where applicable.

J. Bond Requirements

The subcontractor will be frequently required to put up performance and labor and material bonds concerning its work.

The two most common types of bonds encountered in the construction industry are the performance bond and the labor and material bond (also referred to as the payment bond). The performance bond guarantees that the subcontractor will perform its contract. The "principal" may be a subcontractor and the "obligee" the Company. Often the construction lender is also an obligee on a performance bond, with reference to private work. A performance bond is often combined with a labor and material bond at no additional premium.

Unlike a labor and material bond, a performance bond on which the subcontractor is the principal, usually runs only in favor only of the Company.

The most common labor and material bond used in California is the payment bond. When an owner of real property and a contractor enter into a fixed-price contract for construction, this price is the monetary limit of the owner's obligation to the contractor regardless of the actual costs of the improvement. The owner's obligation to supplier of labor, services, equipment or material is not limited to the prime contract price. The mechanic's lien law does provide a means by which the property owner may avoid paying more than the agreed contract price because of liens by unpaid suppliers. To obtain the benefit of the statute, the owner must file the original contract and record a bond in the office of the county recorder where the property is located before the work of improvement is commenced.

K. Indemnity And Insurance.

A subcontractor may be asked by the Company to indemnify the Company for the subcontractor's negligence in performing the project. Unless the indemnity provision specifically provides for indemnification for the awarding authority's negligence, the indemnification runs only in situations where the subcontractor is negligent, or if the Company and third parties are both negligent (perhaps including the awarding authority as well).

It is often required in the Company's construction contracts that the subcontractor have suitable liability insurance, builders' risk insurance and workmen's compensation insurance. The purpose is to cover any injuries which are suffered by workmen on the project, and the affects of any damage caused by the subcontractor or the Company's defective workmanship. Such insurance normally does not provide coverage for damage to the Company's own work, but such coverage can be approached by obtaining "completed operations" and "products liability" insurance. Such insurance is very expensive. The Company can obtain insurance providing coverage for defective work by its subcontractors, but not as to its own defective workmanship.

V. CONTRACT ADMINISTRATION

A. Follow The Contract Or Get Permission Not To Do So

Whenever the Company confronts a situation where performance of a contract is difficult or impossible, it should immediately communicate with the awarding authority or its agents in order to obtain an appropriate change. Under no circumstance should the Company go forward with a change of the proposed work without authorization, or least an effort to communicate with the awarding authority in some follow-up form of protest. (See discussion above.)

Efforts should be made to ascertain from the awarding authority and its representatives, their understanding of the way the work should proceed. If the Company believes that the awarding authority and its representatives are in error, or if the awarding authority is improperly interfering

with the Company's performance, then appropriate communication should be had with the awarding authority, and an appropriate protest lodged.

B. The Company's Project File Should Be Kept Complete

The Company's time records, job diaries and job files should be kept up to date. All events and developments should be memorialized in writing, particularly with reference to interaction with the awarding authority and its agents. Any changes in the work should be documented. If changes cannot be executed and entered into in a timely fashion before performing the work, the Company should at least confirm in writing to the awarding authority requests for changes in the work.

C. Processing Payment Requests

From a legal standpoint, the Company should make every effort to fully document all of its payment requests. Complete copies of invoices, lien releases and other documentation should be gathered together by the Company and presented with all payment requests. All time records, subcontractors submittals, change order requests and other documents necessary to provide complete documentation of the payment requests should be gathered together and presented with a payment request. A complete file should be kept in chronological order of such payment requests, for ready use should the Company determine it will need to pursue a claim in order to obtain payment.

D. Documentation Of Time Delays

Project managers should make every effort to document each and every non-work day which the Company confronts on a project. Each non-work day should be explained by some form of reasonable excuse such as poor weather, owner interference or some other event outside of the control of the Company. These events should be documented on a daily basis and summarized periodically. Furthermore, the Company should make clear as soon as it can that it will be pursuing extra time to finish the project due to excusable time delays.

E. Problems With Coordination.

The single word which best describes the role of the general contractor during construction is that of the coordinator. Even if the Company only utilizes (in addition to its work force) a grading subcontractor, framer, plumber, roofer, storm drain subcontractor, landscaper and electrical subcontractor, the work of those subcontractors should be carefully scheduled, so that no time is lost because of a lack of coordination. Proper coordination of the various groups involved in a construction project occurs when the Company completes its construction tasks efficiently and expeditiously.

Successful coordination, involves the Company's reaction to the perceived need to continue to introduce and master new methods and techniques of construction in order to conduct operations more
efficiently. The coordination process involves the need to directly coordinate performance of highly specialized and technical processes.

The central aspect of providing efficient coordination is having sufficient supervisory staff to coordinate and provide general direction and supervision of the work and of the progress of the subcontractors on the project. Appropriate procedures for implementing coordination among the various interested parties should be undertaken. In that regard, the Company should maintain proper records and prepare appropriate progress reports.

Construction pre-planning meetings and preparation of a detailed work schedule are tools for the proper coordination of work. Prior to starting work, it is important for the estimators to meet with the Company's project team for review of the estimates, drawings and specifications. The more preplanning done by all elements of the Company's staff on a project, the better the coordination and the less difficult are the potential claims by the awarding authority that the

Company failed to adequately coordinate the project, and thus delayed the project (thus subjecting the Company to liquidated damages). Also, the Company can avoid claims for improperly constructive work, as a result of failure to obtain appropriate coordination.

F. Efforts Should Be Made To Communicate With The Subcontractor's Representatives With Reference To Their Authority to Act, Extra Work and Time Extension Requests

The Company's project manager should begin with the concept that communication with the subcontractor is a high priority item. Such communication will help identify any misunderstandings and potential disputes at an early stage, and hopefully generate a means for defusing those disputes.

Furthermore, a detailed understanding of contract provisions and aggressive interpretation of those provisions (plus documentation of the positions taken by the Company), will assist the Company in successful administration of the project. Also, there will be a minimization of delay and maximization of the potential for recovery of compensation for extra work.

If the Company determines that a representative of the subcontractor, or one of its consultant, is abusing his/her authority, every effort should be made to set the record straight, orally and in writing, especially regarding the agent's misinterpretation of the plans and specification. Furthermore, efforts should be made to at least create a record of that difficulty, should it be necessary to get into a dispute later on.

Because of the implied covenant of cooperation and a potential exposure of third party consultants for interference, a diplomatic but firm approach should be adopted where the Company believes that representatives of the subcontractor are interfering with the Company's performance of the work.

As always, project managers for the Company will be looking for areas of compromise and ways to maximize cooperation with all other parties involved in a project, including the awarding authority's consultants. An image of being a problem solver, and of delivering that which is promised, will assist the Company in reaching its objectives. When the awarding authority's agents refuse to cooperate, the Company should consider utilizing the above referenced techniques of controlling such parties.

Use of the pre-job conference to size up the specific individuals representing subcontractors, and thereafter formulating a strategy based on those initial impressions, may help the Company appreciate at an early time exactly what problems its can anticipate in its dealings with representatives of the subcontractors.

VI. SUBCONTRACT INFORMATION AND ADMINISTRATION

A. The SubcontractAgreement

The typical subcontract form is based in part upon the AGC subcontract form.

The form retains the Company's right to terminate a subcontractor at any time, with or without cause. If the termination is with cause, the Company stands to have far less exposure to the subcontractor for termination payments.

An effort should be made in the subcontract to specifically state the scope of work for the subcontractor and make clear the subcontractor's area of responsibility, particularly with reference to preparatory work, temporary utilities and clean-up.

The subcontract form incorporates the provisions of the contract between the Company and the awarding authority or owner so that the subcontractor is bound to the Company's agreement

with the awarding authority. It is wise to either use a separate dispute clause in the subcontract or specifically provide that the dispute procedure of the prime contract is incorporated into subcontract. The form specifically provides for an option that it may resolve disputes with the subcontractor by a process of judicial reference procedures, thereby seeking expedited resolution of disputes before a retired judge of the superior court.

The subcontract agreement form is effectively utilized, however, only if it is fully filled out and signed. When signing up a subcontractor, by utilizing the subcontract agreement form, one should make certain of the following:

1. Each of the blank spaces in the subcontract agreement relating to the specific details concerning any project should be fully filled in. If any of the spaces are left blank, a dispute could later arise regarding the parties' intent with respect to the information not provided.

2. One should make certain that each of the attachments referred to in the subcontract agreement is, in effect, attached to the subcontract agreement.

3. One should also make certain that the subcontractor's initials appear on each page of the subcontract agreement.

4. It is also important that the Company and subcontractor sign and fully fill out the signature blocks at the end of the subcontract agreement.

There are usually many important features in the subcontract agreement, and project managers should make an effort to be familiar with all of the them. A subcontract agreement will typically provide answers to most of the issues which arise during construction.

Extras are only authorized when in writing under the subcontract. Also, the subcontractor is required to provide full labor and material releases before receiving any progress payment from the Company. The Company has the right under the form to terminate the right of the subcontractors. In addition, the Company's subcontract form contains extensive indemnification provisions, essentially requiring the subcontractor to indemnify the Company against any claim, as it may arise on the job site, except those arising from the Company's own negligence. Also, the Company has extensive insurance requirements for subcontractors, which should be vigorously enforced.

B. Processing Progress Payment and Lien Payment Requests

Payment processing is often the most important phase of subcontract administration. The overriding objectives are:

1. To ensure that, by acceptance of payment, the subcontractor releases all claims for work done to date, minus retention; and

2. To ensure that there are no third party lien or stop notice claimants who might retain a claim against the property or against the Company after the subcontractor has been fully paid.

Before releasing a progress payment to the subcontractor, the Company should ensure that all of the following have been done:

1. One should consult the list of preliminary notices that the Company has received; and the subcontractor should be prepared to deliver a conditional release from each party which has served a preliminary notice.

2. One should keep a record of any parties other than those serving preliminary notices who have registered any kind of a claim regarding the project. A progress payment should not be released until one is satisfied that these claims have been extinguished or waived, or that the subcontractor will be solely responsible for them.

3. If any subcontractor is unionized, the Company should be certain that it knows the identify of every union trust fund to which he/she is obligated to make contributions on behalf of his/her workmen. Note that union trust funds are not obligated to serve a preliminary notice; nevertheless, they have mechanic's lien rights. It is not unusual for a contractor to pay off a lower tier contractor, only to discover that a union trust fund is asserting a mechanic's lien claim on the property.
4. The typical subcontract agreement gives the right to issue joint checks, payable to the subcontractor and any unsatisfied claimants. One should not hesitate to use this device if there is any doubt about the subcontractor's willingness to fairly pay his/her sub-contractors and materialmen. (Note: To be effective, a joint check must be endorsed and payment in full for material and labor covered by the check must be acknowledged by each of the endorsing parties. Thus, it is critical that the joint check include an adequate recitation, prior to the endorsement, waiving all lien and stop notice rights for labor and materials covered.)

It is possible to issue a joint check payable to more than two subcontractors and/or materialmen. Post Bros. Construction Co. v. Yoder, (1977) 141 Cal. Rptr. 28. However, this practice can lead to confusion regarding the respective entitlement of each joint payee to a portion of the proceeds.

5. To preserve the Company's status as a general contractor, checks to subcontractors should be issued on its own bank account. One should avoid paying subcontractors and materialmen on accounts which bear the name of any other related entity to the Company.

6. As an additional precaution, there generally should be a release paragraph on the back of each check issued to subcontractors and materialmen. One form of release, which could be rubber-stamped on the back of checks, would be as follows:

" The payee of this check, by endorsement hereon, acknowledges receipt of payment in full for all work performed and material provided on Tract Nos. through and including (date) and hereby releases and relinquishes all mechanic's lien, stop notice, and labor and material bond rights it may possess for the performance of work and provision of materials thereon. This release is for the benefit of, and may be relied upon by, the owner, the prime contractor, the construction lender, and the principal and surety on any labor and material bond. "

(Endorsement)

7. Workmen who provide labor on a construction project are entitled to a mechanic's lien to secure their claim for unpaid wages. They are not required to file a preliminary notice, and the Company is usually not aware of their identities unless they audit the payroll records of the subcontractor. Usually, it is impractical to require the subcontractor to provide lien releases from all of its workmen. However, if there is any doubt about the solvency or reliability of the subcontractor, one may wish to require such releases on particular construction projects.

8. In reviewing lien releases provided by the subcontractor, it is advisable to conduct a spot check to verify the validity of the releases provided. It is not unheard of for a subcontractor to forge the names of materialmen and of subsubcontractors in order to obtain a progress payment. Spot checks can be done by telephone.

9. Generally, it is desirable to require the subcontractor to use release forms provided by the developer or general contractor. However, in certain instances, the subcontractor may have obtained releases on other forms provided by his/her materialmen and sub-subcontractors. Following is a checklist one can use to determine whether an alternative form of release is valid:

   a. Does the title of the document contain the words "waiver" and "release"?

   b. Does the form show the exact amount received?

c. Does the form show that the amount was received from the payor?

d. Does the form show the payee of the check?

e. Does the release specifically refer to the job on which work was performed or material provided, and specifically name the owner?

f. Does the release form specifically state the date through which full payment is acknowledged?

g. Does the form specifically state that the payee releases (whether conditionally or unconditionally) pro tanto any mechanic's lien, stop notice, or bond right the payee has on the referenced job?

h. Is the form dated?

i. Is the Company name of the releasor clearly shown in the signature block?

j. Is the release form executed by an authorized person, whose title appears on the form?

If the release contains all of these items, it is generally valid. California Civil Code Section 3262.

C. Testing Lien and Stop Notice Claims

Despite careful adherence to the payment procedures discussed above, the Company will receive some lien and stop notice claims. Of course, not all such claims are valid; a significant percentage of all lien and stop notice claims are procedurally defective in some way. Many lien claims are filed in the hope that the Company will pay the claim just to get rid of the claim, without scrutinizing its sufficiency.

The following points should assist one in evaluating lien and stop notice claims:

1. To be eligible for lien rights, the claimant must prove that it contributed to a reasonably permanent work of improvement on the property. Services of a purely transitory nature, such as trimming shrubs and mowing lawns, are insufficient to confer lien rights. Young v. Shriver, (1922), 56 Cal.App. 653. By contrast, the installation of landscaping is sufficient to confer a lien right. California Portland Cement Co. v. Wentworth Hotel Co., (1911), 16 Cal.App. 692.

2. The most important prerequisite to assertion of a lien right is that the material or labor provided must have been used or consumed in the course of constructing a work of improvement. California Civil Code Section 3110. If lumber is delivered to a jobsite, but is subsequently removed by the owner or general contractor without being used in a work of improvement on the site, the materialman has no lien right, even though he/she provided lumber in good faith. California Portland Cement Co. v. Wentworth Hotel Co., (1911), 16 Cal.App. 692.

3. No lien rights attach when work on a planned project does not actually commence. For example, a lumber dealer may not assert a lien for lumber which was milled to the order of a prime contractor, where the work of improvement was never begun; similarly, an architect cannot assert a lien for preparation of plans and specifications when the project was never undertaken. MacDonald v. Filice, (1967), 252 Cal.App.2d 613.

4. Every mechanic's lien and stop notice claimant is required to prepare and serve a Preliminary Notice before any lien or stop notice rights may be asserted. For claims against the owner, the only exceptions are: (1) the prime contractor; (2) other contractors who deal directly with the owner; (3) individual workmen who have a claim for unpaid wages; and (4) union trust funds. For claims against the construction lender, the only exceptions are: (1) the prime contractor; (2) individual workmen who have a claim for unpaid wages; and

(3) union trust funds. If the claim does not fit within these categories of exceptions, the failure to serve a properly executed Preliminary Notice will render the mechanic's lien or stop notice unenforceable. California Civil Code Section 3097.

5. The Preliminary Notice must be given no later than twenty days after the claimant has first furnished labor, services, equipment, or materials to the jobsite. California Civil Code Section 3097(c). The service of a late Preliminary Notice will not completely destroy the claimant's right to recovery, however. If a late notice is given, the notice will only give the claimant the right to assert a lien for a period commencing twenty days prior to the service of the Preliminary Notice. California Civil Code Section 3097(d).

6. The Preliminary Notice must contain the following information:

   a. A general description of the labor, services, equipment, or materials furnished, or to be furnished;

   b. If there is a construction lender, there must be an estimate of the total price of the labor, services, etc., to be furnished;

   c. The name and address of the person furnishing the labor, services, etc.;

   d. The name of the person who contracted for purchases of the labor, services, etc.;

   e. A description of the jobsite sufficient for identification; and

   f. The following statement must appear in bold face type:

NOTICE TO PROPERTY OWNER

"If bills are not paid in full for the labor, services, equipment or materials furnished or to be furnished, a mechanic's lien leading to the loss, through court foreclosure proceedings, of all or part of your property being so improved may be placed against the property even though you have paid your contractor in full. You may wish to protect yourself against this consequence by (1) requiring your contractor to furnish a signed release by the person or firm giving you this notice before making payment to your contractor or (2) any other method or device which is appropriate under the circumstances."

California Civil Code, Section 3097(c).

7. The requirements for the preparation of the Preliminary Notice are strictly construed. For example, a Preliminary Notice was invalidated, and lien rights were lost, because the "Notice to Property Owner" was not in bold face type; James v. Five Points Ranch, (1984), 202 Cal.Rptr. 494.

8. The claimant need give only one Preliminary Notice to the owner and general contractor, even though he/she may later furnish additional materials, services, labor, or equipment not within the scope of those generally described in his/her notice. However, if the claimant furnishes materials, services, etc. to more than one subcontractor, he/she must file a Preliminary Notice as to each. California Civil Code, Section 3097 (g).

9. Many materialmen and subcontractors use printed forms available at builders supply stores for preparing Preliminary Notices. These printed forms generally comply with the requirements of California law (unless they are outdated forms -- many contractors retain a supply of obsolete legal forms). However, the mere fact that the form is sufficient does not end the inquiry. You must read the Preliminary Notice to make certain that the claimant has filled in all of the required information.

10. The current Preliminary Notice form contains a declaration of service, which is designed to simplify service of the form. Currently, a Preliminary Notice may be served in California by (1) personal delivery at the place of address of the persons to be notified; or (2) by first class registered or certified mail. This requirement is often ignored by suppliers, subcontractors, and others. Ordinary mail, first class or otherwise, is not sufficient. Mail delivery must be registered or certified, and the receipt of certification or registration must be attached to the affidavit of service. California Civil Code Section 3097(f).

11. The contractor is required to permit any subcontractor or other claimant to view a copy of the original contract between the owner or developer and prime contractor; this contract must contain the owner's name and address and place of business. If the prime contractor gives the subcontractor or his/her claimants incorrect information about the owner or construction lender, his/her lien may be valid despite incorrectly identifying these parties. Brown v. Superior Court, (1983), 148 Cal.App.3d 891.

12. Like the Preliminary Notice, the mechanic's lien itself must contain a number of required elements. California Civil Code Section 3084 sets out the requirements as follows:

    a. The lien must be signed and verified by the claimant. It need not be notarized, however.

    b. The lien must contain a statement of the demand, after deducting all just credits and offsets.

    c. The name of the owner or reputed owner, if known, must be stated.

    d. There must be a general statement of the type of labor, services, equipment, or materials furnished by the claimant.

    e. The lien must show the name of the person or entity by whom the claimant was employed or to whom he/she furnished the labor, services, etc.

    f. There must be a description of the site to be liened sufficient for identification. The lien need not contain a full legal description, including metes and bounds of the property. If the description is completely inadequate, however, the lien may be invalid.

13. A lien claimant need not wait until a project is completed before recording a mechanic's lien, so long as his/her contribution to the work of improvement has been completed. However, once the work of improvement is "completed" the time for recording a lien begins to run as to all claimants as follows:

    a. If a Notice of Completion was recorded, laborers, materialmen, and subcontractors have only thirty days thereafter to record a mechanic's lien; the general contractor has sixty days. California Civil Code Sections 3115 and 3116. Note that the Notice of Completion must be filed within ten days after completion to be effective. California Civil Code Section 3093.

    b. If, after a cessation of work for a continuous period of thirty days or more, a Notice of Cessation as defined by California Civil Code Section 3092 is recorded by the owner, the lien times are limited to those discussed in the preceding paragraph.

    c. If no Notice of Cessation or Notice of Completion has been recorded, all persons have a period of ninety days after "completion" of the work of improvement in which to file their claims of lien. California Civil Code Sections 3115 and 3116.

    d. The time for recording the lien is computed by excluding the first day and including the last, unless the last day is a holiday (including Saturdays and Sundays). When the deadline falls on a Saturday, Sunday or holiday, the lien is timely recorded on the next business day on which the County Recorder's Office is open.

14. The "date of completion" of a project is a term of art and is often the subject of hot dispute. California Civil Code Section 3086. The following events are considered to constitute "completion" and will start the running of the ninety-day limitation period for recording liens:

    a. Occupation or use of the work of improvement by the owner or his/her agent, when accompanied by the cessation of labor;

    b. Cessation of labor for a continuous period of sixty days;

    c. Acceptance of the work by the owner or his/her agent.

15. If a work of improvement consists of two or more separate residential units, each unit is ordinarily considered a separate "work of improvement" and the time for filing a lien against each such unit commences upon the completion of each unit. California Civil Code, Section 3131. However, courts have held that this requirement is inapplicable to condominiums.

16. When a lien is placed upon an entire tract and/or where the claimant's work or materials were supplied for more than one residential unit or other work of improvement, the lien will be "postponed" to other liens unless the notice and claim designates the amount due on each of the buildings or other improvements. The claimant may estimate the proportionate amount due on each building.

17. No mechanic's lien binds property for a period longer than ninety days unless a lawsuit to foreclose the lien is commenced in a proper court within that time. The sole exception is when a "Notice of Credit" is recorded, which may extend the period for up to one year. California Civil Code Section 3144.

18. The mechanic's lien remedy is not exclusive. A claimant may invoke any other remedies he/she may have, including a suit against the subcontractor, the service of a stop notice, a claim against any applicable bond, or any other available relief.

19. There is no relative priority among mechanic's liens, provided that the liens are all recorded within the prescribed statutory time limit. However, all mechanic's liens enjoy priority over any other type of lien encumbrance, deed of trust, or other claim to title which has attached subsequent to the commencement of the work.

20. The function of a stop notice is slightly different than that of a mechanic's lien. A stop notice is a device used to place a "hold" on undisbursed construction loan funds. Any person entitled to a mechanic's lien other than a union trust fund may serve a stop notice. California Civil Code Section 3158-3159.

21. The stop notice is ordinarily served on the owner and construction lender. It must be served prior to the expiration of the claimant's time period to record a mechanic's lien against the property as defined in California Civil Code Sections 3115-3117. California Civil Code Section 3160.

22. A stop notice claimant must furnish the same Preliminary Notice as a mechanic's lien claimant. Otherwise, the stop notice is unenforceable. California Civil Code Section 3160(a).

23. California Civil Code Section 3103 provides that the stop notice must contain the following information:

    a. A general description of labor, materials, and/or services furnished;

    b. The name of the person for whom the labor, materials and/or services was furnished;

c. The value of the work or material already furnished and the value of the entire amount of work or material to be furnished;

d. A verification.

24. Unless a stop notice is accompanied by a bond issued by a recognized surety, it need not be honored by a construction lender. California Civil Code Section 3083. However, some lenders voluntarily honor unbonded stop notices.

25. To be valid, a stop notice must be served on the owner or construction lender within the time permitted for recording mechanic's liens. California Civil Code Section 3160(b). The stop notice must be served personally or by registered or certified mail. California Civil Code Section 3103.

26. An action to enforce a stop notice may be filed no sooner than 10 days after the stop notice has been served, and no later than 90 days after the expiration of the period during which mechanic's liens may be recorded. California Civil Code Section 3172.

27. The Company should avoid dealing directly with materialmen and sub-subcontractors with which they have no direct contractual relationship. If the Company begins dealing with these parties directly, they may later claim a direct contractual agreement, which can confer lien rights they would otherwise not enjoy.

D. Claims on Payment and Labor and Material Bonds

1. In some cases, the Company may require its subcontractors to provide payment and labor and material bonds to secure their performance on construction projects. The value of such bonds depends, in large degree, on the timing of the steps taken to enforce the rights provided by the bond.

2. The most critical thing to remember about bonds is the importance of notice to the surety. Generally, bond rights arise from the contractor's failure to perform pursuant to the provisions of his/her contract. Therefore, if it appears that the contractor is not going to be able to perform his/her contractual obligations, notice should be given to the surety immediately.

3. The three defenses sureties typically raise are: (1) lack of timely notice; (2) lack of opportunity to rectify the problem; and (3) a material change in the obligations imposed on the bonded contractor, without notice to the surety. These defenses can be easily overcome when you can show that the surety has been kept on full notice of the problems encountered with the contractor's performance and has been given the opportunity to consult with you and/or remedy any problem, consistent with timely performance of the job.

4. In some instances, it may be completely impractical to involve the surety in rectifying a jobsite problem. For example, if the contractor simply quits the job, and work must be continued through the immediate employment of another contractor, there may not be time to rectify the situation. Nevertheless, you should build the best paper record possible to show that the surety was (1) notified; and (2) was not willing to act in the limited time available.

VII. ADMINISTRATION OF CLAIMS

A. Right of Way Problems

Frequently, the first "claims" experience of the Company on a project will be its obtaining the right of access to various portions of the project. Section 2-8 of the Green Book provides:

"Rights of Way, Easements or Rights of Entry for the work will be provided by the agency. Unless otherwise provided, the contractor shall make arrangements, pay for, and assume all responsibility for requiring, using and disposing of additional work areas and facilities temporarily required. The contractor shall indemnify and hold the agency.

Appended hereto as Appendix "A" is a chart from a CEB publication setting forth the relevant time limitation periods which govern the processing of construction lien and bond claims.

Appended hereto as Appendix "B" are various sample construction lien forms from the same CEB publication. harmless from all claims for damages caused by such actions."

At Section 8-1.09 of the Standard Specifications of the Department of Transportation, it is provided:

"*If, through the failure of the state to acquire or clear right of way, the contractor sustains loss which could not have been avo ided by the judicious handling of forces, equipment and plant, there shall be paid to the contractors such amount as the engineer may find to be a fair and reasonable compensation for such part of the contractors actual loss, as, in the opinion of the engineer was unavoidable.*

** * **

"Actual loss shall be understood to include no item of expense other than idle time of equipment and necessary payments for idle time of men, cost of extra moving of equipment, and cost of longer hauls. Compensation for idle time of equipment will be determined as provided in this section . . . and compensation for idle time of men, will be determined as provided in Section . . . "labor", and no mark-up will be added in either case for overhead and profit. The cost of extra moving of equipment and the cost of longer hauls will be paid for as extra work as provided in Section 4-1.03D.

If performance of the contractors work is delayed as the result of the failure of the Department to require or clear right of way, an extension of time determined pursuant to the provisions of Section 8-1.07 . . . will be granted . . ."

B. Documentation and Proof of Claim

The Company will encounter events and increased costs which may be identifiable as claims. Essential steps in the evaluation, preparation and proof of claims include:

1. **Fact Finding**, including investigations at the project site and elsewhere of the events of the performance considering plans, specifications, drawings and other terms of the contract. This process includes not only the reading of all documentation (job logs, quality control and field reports, correspondence, contract and modification documents, etc.) but also the interviewing of persons familiar with the project conditions. Timeliness of inquiry is obviously essential, including the taking of photographs, preservation of soils data and other physical evidence, and the need to coordinate with subcontractors, consultants and others. The investigation should include not only the technical tasks of the performance, but also the costs associated with the potential claims.

2. **Analysis** of the events and costs, with consideration to the sequence of the work as originally scheduled, changes in the sequencing caused by delays, the source of the delay, changes directed or necessitated by deficient design, comparison of original contract work with work actually being performed, the use of scheduling techniques, such as the critical task method, and the need for timely notice of claims (in writing to the appropriate agency representative), the evaluation of estimates used in the bidding with the cost being incurred in performance, including an estimate of costs to complete, etc.

3. Identification of Contract and Legal Bases Upon Which a Claim May Be Presented . The various contract clauses, specifications and other provisions such as the changes, different site conditions (changed conditions) suspension of work, time extension and other provisions, including the need for conferring timely written notice to representatives of the agency, have to be implemented.

4. The Preparation of a Draft of the Claims Narrative and exhibits for review by persons knowledgeable on events and costs followed by a finalization of the draft to a well documented claims package. This is an important step in the entire claims recovery process. It is a significant tool in the evaluation of the claim by Company personnel and frequently is the basis for a successful or unsuccessful resolution of claims.

5. Establishment of a Timetable for the Pursuit of the Claim allowing adequate time for preparation, presentation, audit, fact finding discussions, settlement negotiations and the disputes or litigation procedures.

To optimize the recovery of claims, the Company, having conducted actual investigations and study of the terms and legal principals, has to use care in the documentation and presentation of the claim to establish credibility. This process begins with realistic assessments of the "good and bad" and a willingness to present fairly the data to the agency for evaluation. Not only must there be a factual presentation of events but also of costs dependent upon the use of estimates, projections and/or incurred costs.

C. Anticipate Claims and Claim Avoidance

The Company is most frequently benefitted by its representatives in anticipating the potential for claims. If you observe circumstances which tend to indicate that there may be a dispute later on, involving cost, time extensions or some other important factor, than it is probably appropriate to actively consider the potential of the claim situation, and prepare for it. Likewise, if at all possible, the potential claim situation should be avoided by taking whatever appropriate action, if that action is no more than simply giving oral or written communications.

D. Communicate to Solve Problems.

A constant theme of these materials is the need to communicate with the agency or owner representatives and with your subcontractors. Likewise the need to communicate internally at the Company, is clear, particularly with reference to efforts to identify and avoid potential claim situations. In addition to anticipating problems, communication of information to resolve or avoid the problems is critical.

E. Identify Problem Representatives of the Owner or Agency And React Accordingly

As early as the first job meeting, you can make an evaluation as to whether a particular job is a candidate for a claims situation. Is the agency's outside engineer or inside engineer a person who seems to like to engage in debates or is somehow not cooperative? If there is anything wrong in your initial impression of agency representatives, or engineers, than perhaps you should anticipate the need to carefully document the companies position and to frequently communicate with the agency in question, in order to avoid claims situations. The same is true of your initial encounters with subcontractors on any given job. The efforts should be to identify particular problems as soon as possible, whether they be with representatives of the agency or subcontractors or some other circumstances and provide an appropriate Company response even if that is no more than a written communication to preserve the record.

F. Examples of Constructive Change Orders Resulting In Claim Situations.

In addition to the entitlement to a constructive change order for the deficiencies in design for which the owner is responsible, the Company may be entitled to the application of the constructive change order doctrine if:

1. There is an increase in the level of inspection over that which was originally required under the contract.

2. There is a limitation on the Company's work method which precludes the Company from options otherwise available under the contract with regard to sequencing and other aspects of the work.

3. There is an impossibility or impracticability of performance for which the owner has undertaken the risk.
4. There is an acceleration or delay in the work for which the owner is responsible.

5. There is an erroneous interpretation of the design or specifications for which the owner is responsible and an owner's directive causes extra work.

6. There is an erroneous rejection of the work by the government.

G. Dealing With Unforeseen Conditions On the Job.

The "Changed Conditions clause" typically provides that in the event the physical conditions at the site of the project varying materially from those represented or reasonably anticipated and in a manner which increases the time or the cost of performance, the Company is entitled to additional compensation or an extension of time.

One purpose of the clause is to secure a lower contract price by inducing bidders to refrain from including in their bids contingencies for such things as unknown subservice conditions. Some clauses may provide for an increase in the contract price in the event the conditions differ in some manner as to reduce the cost of performance.

Most contracts contain a provision requiring bidders to examine the site of the work prior to submitting a bid. The contractor is charged in such a case with knowledge of all conditions which would have been discovered in the course of a reasonable site investigation. In the absence of such a clause, bidders generally are not required to conduct an investigation of the site and are not charged with knowledge of conditions which could have been discovered only by inspecting the site.

The knowledge charged to a contractor under these circumstances is that which would have been discovered only by a reasonable site investigation and an intelligent contractor. Thus, the contractor is not charged with knowledge of conditions which could not have been discovered without the assistance of an expert in some field of science such as geology.

Notwithstanding his/her duty to investigate, the contractor is entitled to rely on any specific representations by the owner respecting the condition of the site. Such representations may be construed as warranties which are breached if the conditions are materially different. A contractors right to recover on this theory may require proof of reliance by the contractor.

The contractor is required to furnish notice of any changed condition. The giving of such notice within a specified period is a condition precedent to the right of any relief which might be due. Failure to give notice within the required time may not operate as a waiver of rights if the existence of the changed condition is known to the contracting agency.

H. Time Extensions.

As soon as you become aware of time problems with reference to completing a project, those time problems should be documented in an appropriate request for a time extension under the contractor and directed to the awarding authority. A standard clause in contracts for construction provides for an extension of time in the event completion is delayed by certain kinds of events beyond the control of the contractor. Such clauses frequently provide also that the contractor's sole remedy for certain delays is an extension of time of performance, thus precluding any right to recover additional costs occasioned by the delay. Typically, delays which permit an extension of time are those caused by such things as acts of God, weather, action by government, and delays by failure to act attributable to other contractors.

I. Identify and Communicate Extra Work Requests Before They Are Needed.

If at all possible, it is a good idea to identify and communicate to the awarding authority the needs for extra compensation, e.g. change orders, before they are needed. In short, if you anticipate that extra work is going to be required that situation should be communicated to the awarding authority and appropriate change order requested, or at least a written communication of direction from the agency requested.

J Where The Project is Reduced In Scope As to Certain Work Items Below Which Is Economically Feasible.

There may be circumstances where the amount of work in question is less than originally anticipated, so much so that the unit price put in the bid is no longer realistic. The Green Book has a 25% rule where if a unit of work is reduced by change order more than 25% of the work, than the pricing schedule for the work is changed to a time and materials basis. The Company should identify as soon as possible the need to rely on such provisions where the work is reduced, and takes steps to document a request for such compensation before undertaking the work if at all possible.

K. Set Up and Document Claim Book.

The claims documentation as the central basis for settlement of claims requires organization and substance. The essential questions of entitlement to recovery, the legal basis therefore, the amount of monies claimed and/or the time for which the claimant asserts a right have to be addressed, including the use of suitable exhibits. The narrative should include a brief beginning summary of the nature of the claim. It should also include a complete statement of the facts, a detailed chronology of events, and references to applicable legal rules including contract provisions, specifications and other terms. The narrative should also include a presentation of costs which are directly related to the claims and time associated. For example, a narrative may seek the recovery of extended overhead and adverse effects to the project as a whole due to a multiplicity of changes and other events for which the awarding authorities is responsible.

Such claim documentation has to be correlated to include computation of labor inefficiencies, extended overhead and other costs as applicable. Also, the Company should consider suggesting to the awarding authority the Company's willingness to have its costs audited.

L. Consult With A Lawyer.

In many instances, Company management will probably want to consult with its counsel, particularly as to major claims, in order to coordinate preparation of a persuasive claims presentation, to prepare an appropriate negotiation strategy, and for pursuit of the claim in litigation.

M. Define Goals of Claim Administration.

Very early on, Company representatives should ascertain what their goals are based upon a full evaluation of all the facts and circumstances. In short, how much money do you want from the claim, how much of a time extension, and how much are you prepared to settle for? Once you have determined the answer to these questions, then the Company can ascertain an appropriate claims strategy, which can be implemented.

N. Prepare Claim Chronology and Documentation.

It is essential to prepare as a part of the claim documentation, a detailed chronology of the events, concerning the claim, backed up by a chronological set of documents, including correspondence on the subject claim. This helps document the Company's position, aids communication with the agency, and assists the Company and its lawyers in presenting the Company's position in litigation.

O. Bite the Bullet and Settle.

In general, it is quite appropriate for a Company to identify its goals, document its position and arrive at a strategy for obtaining the best possible result under the circumstances in the claim. Once the Company has ascertained the awarding authority attitude, the Company should determine the best amount that it is able to obtain through settlement and agree to settle if that appears to be the most appropriate way to proceed.

P. Use Arbitration Rights.

Wherever the Company has given rights to litigate its claims expeditiously, it should initiate those rights, generally arbitrate as soon as possible, and be prepared to move the arbitration proceeding along as quickly as possible. The Company should form an appropriate negotiation team, including its attorneys for pursuit of the claim, formulate and implement an appropriate strategy for settling the claim expeditiously.

Q. No Damages For Delay Clauses.

One of the most common express contractual limitations on remedies used in construction contracts, particularly those with governments, is a provision which purports to deny the contractor the right to recover damages for delay against the owner. Normally such provisions are quite broad, and are, as a general rule, upheld by the courts. No damages for delay clauses are considered to be in the public interest when used as a means of protecting public agencies against inappropriate claims. Some clauses have at times been read literally so as to preclude recovery for any delay. But there are several exceptions to the general rule that the clause is a legitimate vehicle. The courts will first look to the language of the clause and to other relevant circumstances to see if it is appropriate to enforce the clause.

R. Pursuit of Third Parties.

If the outside engineers retained by an awarding authority or other third parties are inappropriately interfering with the Company's handling of the contract, appropriate communications could be addressed to those parties informing them that their conduct could be actionable. In short, the Company can pursue claims against those third parties because of their interference. It is appropriate to communicate with those third parties, diplomatically, to inform them of their erroneous position, and to inform them that they face of their erroneous position, and to inform them that they face liability exposure. The goal should be to work harmoniously with such parties at all times, but if necessary, they should be placed on notice of their liability exposure.

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WHAT DID YOU LEARN?

1. Prescriptive standards are:

   a) just what the doctor ordered
   b) rules of thumb that are better than engineering
   c) legal standards that have passed the test of time
   d) construction provisions that do not require an engineer or architect

2. Seismic retrofit construction requires an engineer or architect when:

   a) homes are built over slopes steeper than 3:1
   b) foundation walls are constructed with unreinforced masonry
   c) there are more than four dwelling units in a structure
   d) balloon framing exists
   e) all of the above

3. The following statement is false:

   a) the closer you are to an earthquake source, the greater force you will feel
   b) soil and rock formations under a structure can amplify earthquake forces to a building
   c) the more the ground accelerates, the greater forces the building will encounter
   d) buildings that survived past earthquakes do not need to be retrofitted

4. The following statement is false:

   a) the more a building weighs, the greater earthquake forces it will experience
   b) the taller a building is, the more the roofline will move during an earthquake
   c) reroofing can not change the seismic performance of a building
   d) parts of buildings that are not tied together can vibrate apart during an earthquake

5. The following statement is false:

   a) the greatest earthquake force occurs at the base of the structure
   b) the cripple wall is usually the weakest part of the structure
   c) more earthquake forces exist in first story walls than in second story walls
   d) the length of plywood determines the length of a shear wall

6. Shear walls:

   a) provide strength and stiffness like wood I-beams to resist uplift and shear
   b) require holdowns when their weight cannot resist uplift
   c) work best with continuous footings underneath them
   d) are only one part of a complete horizontal force-resisting system
   e) all of the above

7. Retrofit work requires:

   a) evaluation of the condition and species of the existing framing lumber
   b) marking location of studs for sheathing nailing
   c) pre-drilling hard dense lumber
   d) providing underfloor ventilation when missing or insufficient
   e) all of the above

8. The following statement is false:

   a) oriented strand board expands more than plywood when wet
   b) all 15/32 and ½ inch Structural 1 plywood is five-ply
   c) Structural 1 panels are stronger and stiffer grades of wood structural panels
   d) you cannot substitute oriented strand board for plywood without approval
   e) plywood and OSB can be installed vertically or horizontally

9. The recommended fastener for shear wall sheathing is:

   a) full headed common nails
   b) gun nails
   c) 8d or 10d
   d) cooler, box, or sinker nails
   e) wood screws

10. The following is false:

   a) sheathing nails with larger edge distances in framing members produce stronger shear walls
   b) sheathing nails with larger shank diameters and head sizes produce stronger shear walls
   c) sheathing nails with ¾-inch edge distance on the sheathing makes stronger shear walls than shear walls with 3/8-inch edge distances
   d) sinking the nail head below the surface of the sheathing does not reduce the strength of the shear wall

11. The following locations on shear walls require nails at the closer edge distance spacing:

   a) uppermost top plate
   b) sill or sole plate
   c) all holdown studs
   d) all panel edges and around all reinforced openings
   e) all of the above

12. The following are good holdown installation practices:

   a) countersinking nuts and washers in end posts
   b) drilling ¾-inch holes for 5/8-inch bolts
   c) installing drilled-in-anchors for holdowns the same depth as for sill plate anchoring
   d) following both the plans and the manufacturer's installation instructions
   e) allowing small kinks in metal straps

13. Shear connections are:

    a) connections from the top plate to the shear wall
    b) connections from the shear wall to the floor framing below
    c) connections from the sill plate to the top of the foundation wall
    d) connections that prevent any two parts of the building from sliding past each other

14. The following statement is false:

    a) expansion and adhesive anchors must be located a minimum distance from any edge of the concrete
    b) adhesive anchors require clean holes and threaded rods
    c) plate washers increase the strength of the sill plate connection
    d) the depth of the all-thread rod and adhesive in the concrete determines the strength of a retrofit holdown
    e) lag screws do not have to be pre-drilled if they do not split the wood

15. To be an effective part of the horizontal force-resisting system, foundations should:

    a) be free of excessive cracking or deterioration
    b) be continuous around the perimeter of the building
    c) have enough strength, depth and weight to resist shear and uplift forces
    d) be evaluated by an architect or engineer
    e) a &c

16. The following statement is false:

    a) porches and patio covers should be well-connected to the rest of the house
    b) unstrapped electric and gas water heaters can cause fires
    c) masonry chimneys can be retrofitted by simply adding a brace to the roof
    d) 50% of all earthquake damage costs are non-structural in nature

17. The length of time for liability for personal injury following completion of construction is:

    a) three years for construction defects
    b) fours years for patent defects
    c) 10 years for latent defects
    d) until death do you part

18. A good contract should contain many things, such as:

    a) clear scope of work, completion date and how to handle changes in the work
    b) be prepared under specific legal counsel
    c) exculpatory provisions, price and payment schedule, &termination provisions
    d) a loose definition of the work to allow for money-making extras
    e) a, b &c

ANSWERS: 1-d, 2-e, 3-d, 4-c, 5-d, 6-e, 7-e, 8-b, 9-a, 10-d, 11-e, 12-d, 13-d, 14-e, 15-e, 16-c, 17-d, 18-e

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