THE UTAH GUIDE FOR
THE SEISMIC IMPROVEMENT OF
UNREINFORCED MASONRY DWELLINGS

Utah Seismic Safety Commission
Existing Buildings Committee
Second Edition
2016
PREFACE

This publication is prepared for information purposes to assist owners of unreinforced masonry (URM) dwellings (homes) in gaining a better understanding of the seismic improvement of their dwellings. It is recommended that owners enlist the expertise of a Utah-licensed contractor or repair specialist prior to the implementation of the fixes illustrated herein. While several generalized dwelling types are addressed in this publication, each home is unique and for greater assurance and reliability, a Utah-licensed Professional Engineer and/or Architect should be retained to design and detail specifically tailored corrective measures. This document is intended for general informational use by homeowners and small residential contractors, and if any non-dwelling building or other non-residential commercial building repair is being considered, the owner should certainly involve a Utah-licensed Structural Engineer. This publication is not to be used as a construction document.

The agencies and businesses involved in the design and preparation of this publication accept no responsibility for rehabilitation work or any action taken based on information found in this publication.

Unreinforced masonry and lightly reinforced masonry dwellings were typically constructed prior to 1975. Beginning in 1973, the building codes began to introduce more significant seismic requirements. Such dwellings were commonly constructed using solid masonry bearing walls without adequate steel reinforcing. As a result, URM dwellings lack the ductility required to absorb seismic energy in a significant earthquake. Often, the dwellings are quite brittle and lack proper attachment between the walls and roof, preventing the roof from stabilizing the wall. In multi-story dwellings, the same concept applies to attachments between the floor and walls. Because of these structural deficiencies, URM dwellings can quickly fail during earthquakes and should not be expected to perform adequately during a large earthquake.

While it is impractical to make any dwelling earthquake proof, the techniques shown in this publication are intended to generally improve the seismic performance of a URM dwelling. Potential earthquakes have a wide range of magnitudes and other characteristics and it should be expected that damage can still occur, even after the upgrading of URM structures. Moderate magnitude earthquakes occur periodically and, although minor damage is usually associated with these events, they have been known to cause major damage. High magnitude earthquakes (such as, above magnitude 6.75) have been known to cause damage to even strengthened or partially-strengthened structures. Generally, the more seismic upgrade measures that are taken to improve any given structure, the greater the potential reduction in damage due to the earthquake. The purpose of this guide is to minimize the possibility of a catastrophic failure of a dwelling by the implementation of seismic upgrades, all in an effort to mitigate the loss of life during a major earthquake.
ACKNOWLEDGMENTS

One important strategy identified in the Utah Seismic Safety Commission’s (USSC) 1995 publication *A Strategic Plan for Earthquake Safety in Utah* was the need to provide seismic strengthening of existing dwellings. The USSC partnered with the Structural Engineers Association of Utah (SEAU) in advocating the statewide adoption of existing dwellings building codes and other regulations.

In the 2008 progress report, *Earthquake Safety in Utah*, the USSC describes its action plan and target focuses that include: learning about, building for, and living with earthquakes. Under the building for earthquakes focus, is an initiative for improving vulnerable dwellings. This guide is the outcome for this initiative in that seismically upgraded dwellings will reduce the loss of life and property in the event of an earthquake.

The *Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings* (Utah Guide) has been reviewed, expanded, and updated by the combined efforts of the SEAU, the USSC, the Utah Division of Emergency Management (UDEM), and the Federal Emergency Management Agency (FEMA). A special thanks to the SEAU/USSC Existing Building Committee (EBC) Chairs, Glen Palmer and Barry Welliver, for managing this project, and to the members of the Utah Guide Subcommittee of the EBC: Brian Warner, Zach Hansen, Curtis Earl, Roger Evans, and Bob Carey, who have donated their time and expertise.

FEMA and the UDEM, through the Earthquake Preparedness Program, provided funding for the update to the original Utah Guide, resulting in this second edition.
Acknowledgments (Second Edition – 2016)

Contributors
Structural Engineers Association of Utah
Utah Seismic Safety Commission, Existing Buildings Committee
   Existing Buildings Subcommittee on the Update of the Utah Guide
      Roger Evans, Past USSC Chair
      Glen E. Palmer, S.E., EBC Chair
      Barry H. Welliver, S.E., Past EBC Chair
Technical Editing Subcommittee Members:
   Brian Warner
   Zach Hansen
   Curtis Earl
   Glen E. Palmer

Utah Department of Public Safety, Utah Division of Emergency Management
   Robert Carey, Earthquake Program Manager
   Sheila Curtis, Operations Planner

Federal Emergency Management Agency
   Doug Bausch, FEMA Region 8

Publication Editorial Review, Formatting, and Production (Utah Geological Survey)
   Steve D. Bowman, Ph.D., P.E., P.G., Geologic Hazards Program Manager
   Vicky Clarke, Publications Manager

Acknowledgments (First Edition – 1996)

Contractor
   Reaveley Engineers & Associates Inc.
      675 East 500 South, Suite 400
      Salt Lake City, Utah 84102

Utah Division of Comprehensive Emergency Management (CEM)
   Lorayne Frank, CEM Director
   Robert Carey, EPICENTER Manager
   Judy Watanabe, Natural Hazards Planner
   Brenda Edwards, Natural Hazards Office Technician
   Caryn Johnson, Natural Hazards Section
   Mikki Easton, Natural Hazards Section
   James Tingey, as he was instrumental in initiating this project

Special thanks to:
   Lawrence D. Reaveley, Ph.D., S.E.
   Mark R. Harris, S.E.
   Debra A. Lewis, Structural Technician
   David J. Wagner, A.I.A.
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CHAPTER 1

Introduction

Residential dwellings (homes) constructed under the current provisions of the International Building Code (IBC), International Residential Code (IRC) and other subset codes (including amendments adopted in Utah), (http://le.utah.gov/xcode/Title15A/15A.html), require that they be designed and built to resist a specified minimum level of forces that might be generated by an earthquake. Dwellings built prior to the adoption and enforcement of these codes almost always do not provide the desired earthquake resistance, (figures 1 and 2), as is common with unreinforced masonry (URM) structures. URM materials consist of stone, brick, block, or rock that is only held together with mortar (no or little reinforcing steel). However, even dwellings designed and constructed today with this minimum level of resistance could still experience considerable structural and non-structural damage due to the fact that minimum code requirements focus only on the safety of the dwelling’s occupants without considering the future usability of the dwelling. This is especially true as ground shaking that exceeds the level anticipated by the building code adopted at the time of design and construction can occur resulting in increased damage to structures.

The concept of upgrading existing dwellings to resist seismic forces from earthquakes is increasingly common in Utah. The majority of this work has been performed on commercial structures, rather than residential dwellings. However, the level of exposure from high profile upgrade projects of complex dwellings has raised the misconception that seismic upgrades are difficult and prohibitively expensive. URM dwellings are usually far simpler than these more prominent projects, but still pose a significant risk due to the quantity of these vulnerable dwellings in Utah that include over 147,000 URM dwellings and other structures in Box Elder, Cache, Davis, Juab, Morgan, Rich, Salt Lake, Summit, Tooele, Utah, Wasatch, and Weber Counties (Earthquake Engineering Research Institute, Utah Chapter, 2015).

![Figure 1. Braced exterior wall of a URM dwelling after an earthquake.](image-url)
Earthquake ground shaking has been found to be very damaging to URM buildings, including dwellings. Seismic forces exerted on a dwelling during an earthquake are a function of the mass, or weight, of the dwelling. The seismic resistance of a dwelling depends on the strength and ductility of the horizontal (lateral) force resisting elements. Due to the relatively high mass and the low ductility of URM materials, these dwellings generally perform poorly in moderate to large earthquakes (generally greater than magnitude 6.75). Previous earthquakes have shown that URM structures are the most vulnerable of all building types to the forces generated by a seismic event. Relatively small levels of ground shaking can cause significant damage to a URM structure. Moderate to large levels of ground shaking have the potential to cause structural collapse to a portion or all of the structure (figures 3 to 12). Additional information on the earthquake hazard, risk, and possible mitigation measures is also available in Appendix A, the USSC publication Putting Down Roots in Earthquake Country: Your Handbook for Earthquakes in Utah (https://ussc.utah.gov/pages/help.php?section=Putting+Down+Roots+in+Earthquake+Country+Handbook), and from the Utah Seismic Safety Commission (https://ussc.utah.gov).

This guide is designed to educate homeowners with respect to the effects of earthquakes on URM dwellings and addresses how individual homeowners can make their own assessment of possible seismic deficiencies and how to improve them. This education process is facilitated by using seven typical model dwellings representative of a wide spectrum of the URM dwellings commonly found

Figure 2. Cracks and failure of a Richmond, Utah, home from the 1962 magnitude 5.7 Cache Valley earthquake. The damage was extensive enough that this house was torn down. Photo: Ariel Benson.

Figure 3. URM structure collapse.
in Utah. A homeowner can examine the architectural features, configuration, and materials of their dwelling and then compare these observations to the model dwellings in this guide. It is usually possible to make some direct correlations between the specific dwelling and one or more of the model dwellings. The seven model dwellings are described in Chapter 5, with photographs and drawings provided to help illustrate the different model dwelling types. Basic seismic deficiencies are noted for each model with suggested corrective measures.

The procedures contained in this guide will not provide the homeowner with a completely earthquake resistant dwelling, but will help improve the seismic performance of the URM dwelling during an earthquake, reducing the risk of collapse. If it is not feasible to make all of the proposed seismic improvements, any work performed will generally be beneficial. The improvements should, as a minimum, include the anchorage of the exterior walls to the roof and floor structures. Detailed engineering analysis and design by a Utah-licensed Professional Engineer is recommended in order to achieve a greater level of confidence in the strengthened dwelling.

Chapter 2 provides directions for using this guide, including how to select the most important areas for improvement and how to implement the actual fix. A flow chart (figure 11) has been included to aid in the use of this guide.

Chapter 3 provides a basic description of earthquakes and the effects they have on structures, including dwellings. It describes structural elements present in all structures, how these various elements interact during a typical earthquake, and how implementing the improvements in this guide are important.

Chapter 4 illustrates typical features of URM construction and discusses earthquake deficiencies that may exist in URM dwellings. Additional descriptions and illustrations of the many structural elements and connections that are prone to failure are also provided.

Chapter 5 includes descriptions, photos, and illustrations of seven model URM dwellings described in this guide. It is usually possible to make some direct correlations between the specific dwelling and one or more of the model dwellings. The seven model dwellings are described in Chapter 5, with photographs and drawings provided to help illustrate the different model dwelling types. Basic seismic deficiencies are noted for each model with suggested corrective measures.

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dwellings. The intent of this chapter is to identify the type of construction that is most similar to a homeowner’s dwelling. This can be performed by making comparisons between the homeowner’s dwelling and the photographs and drawings of the typical model dwellings. It may be that the homeowner’s dwelling is a combination of two or more of these models. Included with each model, is a list of its seismic deficiencies and table 1 lists suitable improvement details applicable to each seismic deficiency.

Figure 6. URM wall collapse on a Richmond, Utah, house from the 1962 magnitude 5.7 Cache Valley earthquake. Photo: Ariel Benson

Figure 7. Earthquake damage to an URM wall and displacement of mechanical equipment on roof.

Figure 8. URM wall failure from an earthquake.
Chapter 6 provides conceptual details for upgrading the seismic deficiencies described and/or referred to in Chapter 5. These details are generally arranged in rank priority with the most important seismic improvements shown first. These conceptual details are general in nature and have been developed to allow a certain amount of modification to fit the specific deficiency.
Where unusual and/or complex conditions are encountered, specific engineering analysis and design by a Utah-licensed Professional Engineer and/or Structural Engineer may be required.

Chapter 7 includes general details for upgrading (bracing, anchoring, etc.) non-structural seismic hazards. These are typically elements and dwelling contents that are not part of or are not anchored to the dwelling structure (figure 13).

Appendix B contains a glossary and list of definitions for the abbreviations used in this document.
CHAPTER 2

How To Use This Guide

This guide was developed on the premise that the wide range of URM dwellings in Utah can be represented by several typical URM models. Previous experience, by engineers in Utah, has determined that the majority of URM, single-family dwellings in Utah can be described by seven different typical models. Each model has distinct architectural styles, variations in construction and materials, and different configurations.

The details in this guide are referenced using a consecutive numbering system with each detail listing the model type referenced and the general purpose of the basic detail shown. These details are included in Chapters 5 and 6.

The process presented in this guide to evaluate and improve the seismic resistance of a dwelling is shown in figure 14 with four major steps:

Step 1

A. From the seven model dwellings described in Chapter 5, determine which one has the architecture features, configuration, and specific materials most closely resembling the dwelling that is to be improved.

B. It is possible that several structural details showing wall sections will apply to a single dwelling and each potential similar element should be identified for consideration during the seismic improvement process. A Utah-licensed contractor or repair specialist can assist in determining which wall sections apply to a specific dwelling.

Step 2

Using table 1, select corrective measures that appear to be appropriate for the URM dwelling that is to be improved using the improvement details in Chapter 6. The deficiencies are listed in the order of the approximate overall level of safety related to each deficiency and is recommended that they be corrected in the same sequence. As an example, the first and most important corrective measure for most URM homes is to provide a positive connection between the wood roof structure and the exterior walls.

Step 3

For some deficiencies, there are various seismic improvement details that may be used to achieve the same result with advantages and disadvantages for each. Some methods are much more disruptive and would only be practical if a major renovation is being undertaken. The intended procedure is to select the method that is best suited for the circumstances of the specific dwelling. In most instances, the corrective measures will require some modification from the details as provided. The method selected will be dictated by several factors that include the following:

A. Should the entire home or just a portion of the dwelling be seismically improved? This may be related to remodeling or other construction projects planned for the dwelling.

B. Can the architectural and/or historical appearance be altered?

C. How much money is available for the project? This may require the work to be completed in stages.

Each alternative approach should generally provide the same basic result, however some approaches are based on constraints in the desired appearance or construction methods used. Where multiple seismic improvement details are provided, alternative approaches may show different methods of construction or may show differing ways to achieve a different final appearance. Often, a particular owner may feel the need to minimize the risk of damage that may be possible with the various methods of construction or they may not want to alter the basic appearance (such as, brick exterior) of their dwelling. Because some of the alternatives shown do not always consider the final impact on appearance, owners need to be aware that major alterations in the architectural appearance may result.

Step 4

The cost associated with each seismic deficiency should be estimated for the complete list of corrective measures selected, then summed to determine an overall total. The budget for the project can then be used to determine how
far the seismic improvement process can be taken based on available funds. Each task should ideally be placed in the ranked priority shown in table 1. This priority list can also be readjusted to better meet the homeowners’ specific needs considering budget and/or phasing options.

Each corrective measure that is implemented should improve the seismic performance of the dwelling. If a measure is performed out of the suggested order, the desired seismic improvement may not be achieved because of the failure of another structural element. Some measures are much more cost effective than others and this is generally reflected in the suggested order of corrective work. In areas where high levels of ground shaking are probable (IBC Seismic Design Category C through F), seismic improvements that address the top three deficiencies listed in table 1 are recommended as the minimum level of seismic rehabilitation work. In areas where the level of expected ground shaking is moderate to low (IBC Seismic Design Category A and B), the top two deficiencies listed in table 1 should be addressed as a minimum. Corrective work beyond the minimum recommended levels will improve the seismic performance of the dwelling and should be considered. It is generally assumed most areas in the Salt Lake Valley are Seismic Design Category C or D, therefore it is recommended that the maximum number of seismic deficiencies be addressed.

![Figure 14. Dwelling seismic improvement flowchart.](image)
CHAPTER 3

Building Dynamics and Earthquake Forces

The ground shakes when an earthquake occurs and sometimes land and structures are damaged or displaced. When a large earthquake takes place along a fault, there will be widespread damage. However, there are steps that can be taken by homeowners to reduce the damage to their individual dwelling and its contents that are explained in this guide and other related information resources. A better understanding of earthquakes and their effect on a dwelling will help homeowners understand the reasons and importance of implementing seismic improvements to protect life safety and their financial investment.

Utah experiences about 700 earthquakes every year (figure 15). Of this number, about eight are magnitude 3.0 or greater. Smaller magnitude earthquakes are rarely felt by people and typically do not cause damage. However, these small earthquakes are important for studying our vulnerability to larger earthquakes. A moderate and potentially damaging earthquake of magnitude 5.0 to 6.0 occur somewhere in Utah about every 5 to 30 years. Earthquakes occur on faults or cracks in the Earth’s crust. Utah has many faults that could produce damaging earthquakes as shown in the Utah Quaternary Fault and Fold Database (http://geology.utah.gov/resources/data-databases/qfaults/).

<table>
<thead>
<tr>
<th>No.</th>
<th>Year</th>
<th>M</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1884</td>
<td>5.6</td>
<td>Paris (Idaho)</td>
</tr>
<tr>
<td>2.</td>
<td>1901</td>
<td>6.6</td>
<td>Tushar Mountains</td>
</tr>
<tr>
<td>3.</td>
<td>1902</td>
<td>6.3</td>
<td>Pine Valley</td>
</tr>
<tr>
<td>4.</td>
<td>1909</td>
<td>5.6</td>
<td>Hansel Valley</td>
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<tr>
<td>5.</td>
<td>1910</td>
<td>5.3</td>
<td>Salt Lake City</td>
</tr>
<tr>
<td>6.</td>
<td>1921</td>
<td>5.5</td>
<td>Elsinore</td>
</tr>
<tr>
<td>7.</td>
<td>1934</td>
<td>6.6</td>
<td>Hansel Valley</td>
</tr>
<tr>
<td>8.</td>
<td>1937</td>
<td>5.4</td>
<td>ID-NV-UT tri-state area</td>
</tr>
<tr>
<td>9.</td>
<td>1950</td>
<td>5.3</td>
<td>NW Uinta Basin</td>
</tr>
<tr>
<td>10.</td>
<td>1959</td>
<td>5.6</td>
<td>Arizona-Utah border</td>
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<td>11.</td>
<td>1962</td>
<td>5.8</td>
<td>Cache Valley</td>
</tr>
<tr>
<td>12.</td>
<td>1962</td>
<td>4.9</td>
<td>Magna</td>
</tr>
<tr>
<td>13.</td>
<td>1963</td>
<td>5.1</td>
<td>Juab Valley</td>
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<tr>
<td>14.</td>
<td>1966</td>
<td>5.2</td>
<td>Nevada-Utah border</td>
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<td>15.</td>
<td>1967</td>
<td>5.1</td>
<td>Marysvale</td>
</tr>
<tr>
<td>16.</td>
<td>1975</td>
<td>6.0</td>
<td>Pocatello Valley (Idaho)</td>
</tr>
<tr>
<td>17.</td>
<td>1988</td>
<td>5.0</td>
<td>San Rafael Swell</td>
</tr>
<tr>
<td>18.</td>
<td>1989</td>
<td>5.2</td>
<td>So. Wasatch Plateau</td>
</tr>
<tr>
<td>19.</td>
<td>1992</td>
<td>5.5</td>
<td>St. George</td>
</tr>
</tbody>
</table>

*Magnitudes are moment magnitude, M. No further shocks of $M \geq 4.9$ have occurred through June 2015.

Figure 15. Epicenter map of earthquake mainshocks of moment magnitude, $M \geq 2.5$ and larger in the Utah region, 1850 through September 2012; foreshocks, aftershocks, and mining-related seismicity are excluded (Arabasz and others, 2016). Numbered epicenters for shocks of $M \geq 4.9$ are shown in the accompanying table (USSC, 2008).
The 217-mile long Wasatch fault zone (WFZ; figure 16) is one of the longest and most active normal faults in the world, extending from north of Malad City, Idaho, south to Fayette, Utah. Normal faults move where one block (Wasatch Mountains, etc.) move upward relative to the adjacent downward moving valleys (Salt Lake, Utah, etc.). Based on extensive geologic research, the fault is subdivided into ten segments about 20 to 30 miles long with each segment capable of producing its own earthquake independent of the other segments. At least 22 surface-faulting earthquakes (generally, magnitude 6.5 or greater) have ruptured the five central segments (Brigham City, Weber, Salt Lake City, Provo, and Nephi) of the WFZ since about 6000 years ago (Wong and others, 2016).

The Working Group on Utah Earthquake Probabilities has determined that a large magnitude earthquake will occur somewhere on the five central segments of the WFZ about every 1200 years (Wong and others, 2016). In the Wasatch Front region during the 50 year period of 2014–2063, the probability of a large (magnitude ≥ 6.75) earthquake is 43%, and the probability of a magnitude ≥ 6 earthquake is 57% (Wong and others, 2016).


Many dwellings built before earthquake construction design standards were adopted, which include those built about pre-1975, have little or no earthquake resistant design.

Figure 16. Segments of the Wasatch fault zone (WFZ) in northern Utah and southern Idaho. The central WFZ is shown in red, end segments of the WFZ are shown in black, and other Quaternary faults are shown in dark gray. From Wong and others, 2016.
Some of these dwellings, such as wood frame, may be fairly flexible and somewhat resistant to ground shaking. A large number of pre-1975 dwellings in Utah were constructed out of unreinforced masonry (URM). Because of the mass and brittle properties of URM construction, these dwellings perform poorly during earthquake ground shaking. The seismic improvement of URM structures in Utah presents a great challenge to the community. It is usually not practical to try to improve these structures to a level consistent with current seismic building code requirements; however careful long-term planning can lead to the improvement and/or replacement of these URM dwellings and should reduce the resultant damage from earthquake events. Knowledge of potential deficiencies that can cause severe damage during an earthquake will guide the homeowner in correcting many of the problems. Although it may not be possible to upgrade the dwelling to current building code requirements, seismic improvement will almost always help reduce the damage and the associated risk to occupants and the contents of these dwellings.

Over the years, much research has been done to understand the reasons for structural failure during earthquakes. By identifying the strengths and weakness of structures that have been subjected to seismic forces, elements required for the seismic stability of most structure types have been identified. Though the size, capacity, and type of materials vary with each structure, the basic force resisting system must be present in all structures. The basic system to support gravity loads normally includes roof, floor, and wall elements, including solid walls and/or piers, beams, columns, footings, and foundations. A problem found to exist in URM dwellings is that they are intended to carry only vertical gravity loads, but generally have little resistance to the dynamic horizontal forces of earthquakes.

The two main elements in earthquake design are resisting and distributing elements (figure 17). The resisting elements are composed of footings, foundation walls, piers, braced columns, walls, wall bracing, or any other element or combination of elements that helps to transfer earthquake forces back to the foundation wall and footing. Proper connection of these elements to each other and anchorage to the foundation wall and footing is extremely important. If this anchorage is weak or missing, the structure may be displaced, or at worst, it could collapse.

The distributing elements are the floor(s), roof, horizontal bracing, or any other element or combination of elements designed to distribute earthquake forces to the resisting system of the structure. When ground shaking occurs, the resisting and distributing elements must be properly connected to each other in order to allow the structure as a whole to work together to transfer horizontal earthquake forces back to the foundation wall and the footing.

This simple description of the resisting and distributing elements is a very brief overview of what is required for a structure to withstand seismic forces. Chapters 4 and 5 will address many of the construction methods that were common prior to adopting seismic code standards. The adopted building codes in Utah no longer allow structures to be built using URM. There are many dwellings in Utah that are constructed out of URM materials and, although such dwellings have some inherent strength, they have been shown to perform poorly in moderate to large earthquakes. Replacement of the URM dwelling is not normally an economical or historically feasible alternative, as a result, this guide was developed to assist homeowners in identifying and mitigating seismic deficiencies inherent in the most common types of URM construction used in Utah. The following chapters provide an explanation of the weaknesses and the reasonable steps that homeowners can take to improve the performance of their URM dwelling during an earthquake.
CHAPTER 4

Typical Features of Unreinforced Masonry Construction

URM dwellings were designed primarily with structural elements to support only vertical gravity loads with the elements being designed to be strong enough to support the weight of the live loads (people, rain, snow, etc.) and the dead loads (weight of wood, masonry, roofing, contents, etc.) above. Little or no attachment exists from one structural element to the other that works in a static situation where the home is not subject to movement. However, when an earthquake occurs, the elements of a structure are subject to horizontal (lateral) loads, in addition to gravity, live, and dead loads. Structural failure can occur when the elements are overstressed by the additional seismic load and/or by the displacement of adjacent elements.

A typical URM dwelling has many elements where failure could occur. The construction may vary slightly, but they all consist of: (1) a footing and/or foundation wall (concrete, masonry, or rock), (2) load bearing masonry exterior walls, (3) wood frame floor(s), and (4) a roof system. Within the dwelling, there is some type of bearing wall(s) (normally URM or wood) or a beam support system. Each of these major elements could fail individually; however, failure is more likely to occur where one element is adjacent to another.

Foundation Walls

Foundation walls for URM dwellings may be concrete, masonry, or rock. If the foundation wall is URM or rock, it generally breaks apart at the mortar joints during an earthquake with sufficient seismic energy. Many times these walls have significantly deteriorated from moisture penetration over the life of the dwelling. The mortar used in many older dwellings contains very little cement, may be of poor quality, and is normally very soft and weak.

URM Bearing Walls

A bearing wall is defined as a wall that supports any vertical load in a dwelling as well as its own weight (figure 18). In this case, the vertical loads come from the floor and roof systems in a dwelling. The floor(s) and roof are normally composed of wood joists (parallel horizontal wood members) and a diaphragm (plywood or wood boards that create a flat or sloping surface). The wall may be covered by siding, stucco, or other materials concealing the masonry from view.

Figure 18. URM bearing wall.

Figure 19 illustrates three types of URM walls described in this guide. Failure of these walls can happen in several different ways. In-plane failure occurs when seismic forces from an earthquake are introduced parallel to the wall causing the wall to be displaced horizontally within the plane of the wall (figure 20). Out-of-plane failure occurs when seismic forces are introduced perpendicular to the wall and the wall either falls away from the floor(s) and/or roof, or buckles between the floor(s) and roof (figure...
21). The floor joists usually pocket into the masonry and the roof joists normally bear on top of wall. In both cases, there may or may not be a wood plate to which these joists are nailed. Failure of these connections can cause the joists to slide off their bearing support, resulting in full or partial collapse of a floor or roof. Another common failure in multiple wythe (or vertical layer) construction where one or more of the outer wythes of brick may fall away from the rest of the wall, as they are not connected together.

Masonry Piers (Columns)

Masonry piers can be located within the dwelling under the main beam line that supports the first floor or at the exterior to support the roof over a porch (figure 22). In both cases, the pier either continues to the floor or roof, or supports a wood post that then continues to the floor or roof. These piers are subject to the same type of failure as the masonry foundation wall. Taller piers will have tendency to topple or buckle during an earthquake.

Floor and Roof Diaphragms

The diaphragm is the structural element that consists of sheathing fastened to the underlying joists, creating a flat floor/roof or a sloping roof, which distributes forces throughout a particular level of the dwelling (figure 23). Horizontal forces generated in the masonry walls are transferred to the diaphragms. The diaphragms in URM construction generally fail due to the large forces generated from the weight of the surrounding masonry and/or the poor connections tying the diaphragms and walls together.

Interior Bearing Walls and/or Post and Beam Lines

The interior-bearing element may be an URM wall, a wood stud wall, a post and beam line, or any combination (figure 24). This intermediate support is required because the floor and roof joists generally cannot span between exterior walls. These elements will normally fail from inadequate connections or lack of any connections to each other.
Special Features

Most URM dwellings contain the basic structural elements described in this guide, however there are special features that may not be present in all URM dwellings or may vary from one dwelling to another.

The special features covered in this guide include URM parapets, masonry gable end walls, chimneys, and corner windows (figure 25). There are other special features found on URM dwellings, however these are the most common. A description of each of these items, their deficiencies, and references to the appropriate corrective measures are included at the end of Chapter 5.

Figure 24. Bearing wall and post and beam line.

Figure 25. Examples of a parapet, chimney gable end wall, and corner window.
CHAPTER 5

Typical Unreinforced Masonry Dwelling and Seismic Deficiencies

This chapter includes descriptions of seven model dwellings with distinct architectural styles, variations in construction, and different structural configurations typical of URM dwellings found in Utah (figure 26). Photographs of exterior walls and details of typical wall sections are included for each model and can be used to compare the homeowner’s dwelling with the different model dwellings. The objective is to find the typical model dwelling that is most similar to the homeowner’s dwelling. It may be that the homeowner’s dwelling is a combination of two or more of these models. Careful study of the specific conditions at a dwelling will lead to identification of which exterior wall details best match the subject dwelling. Also included with each model dwelling description is a list of its typical seismic deficiencies.

Table 1 lists the deficiencies and corresponding seismic improvement details that may be used to correct the deficiencies. A special features section at the end of this chapter may apply to any of the model dwellings. The details referenced in table 1 are included in Chapters 5 and 6 and follow a consecutive numbering system with each detail listing the model dwelling it is intended to be used with. Not all consecutive numbers are used within the detail numbering system. This is so that future details may be added without modifying the existing numbering and grouping of details used for each model and for each category of seismic improvement.

<table>
<thead>
<tr>
<th>Seismic Deficiencies</th>
<th>Model Dwelling Types</th>
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<td>(In order of highest priority to lowest priority)</td>
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<tr>
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<td>Details 31 and 36</td>
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<td>Roof to URM Wall Anchorage</td>
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<td>Details 32 and 37</td>
<td>Details 33 and 38</td>
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<td>Details 32 and 37</td>
<td>Details 33 and 38</td>
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<tr>
<td>Floor to URM Wall and Foundation Wall Anchorage</td>
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<td>Foundation Wall Strengthening</td>
<td>Detail 90</td>
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<tr>
<td>Non-Structural Bracing and Anchorage</td>
<td>For bracing and anchorage of non-structural items, including water heaters, furnishings, cabinets, equipment, etc., see details 100 and higher.</td>
</tr>
</tbody>
</table>

Table 1. Typical seismic improvement details for model dwelling types A to G for various seismic deficiencies.
Figure 26. Representative model dwelling types.
Model A
Single Story, Double Wythe Brick
with Basement

Model A was built in approximately 1906 and is a single-story dwelling with a full basement (figures 27 and 28). The construction consist of double wythe URM exterior walls, concrete foundation walls supporting a wood floor and roof/ceiling joists around the exterior, and wood stud bearing walls within the dwelling. It has two chimneys, one exterior and one interior, and a porch with tall masonry piers supporting the roof.

The seismic deficiencies observed in Model A are:

1. The lack of anchorage of the roof to the URM exterior walls. There may or may not be a wood plate on top of the typical URM wall which this home did not have.
2. The lack of anchorage of the floor to the URM exterior and concrete foundation walls.
3. The chimneys are not braced.
4. The lack of continuous sheathing makes the roof diaphragm weak. There are 1 x 8 inch wood boards spaced at approximately 12 inches on center.
5. The masonry bearing walls are unreinforced.
6. The tall masonry porch piers are not braced or adequately attached to the porch roof.
7. The interior wood stud bearing walls are not anchored to the floor or roof.
8. The water heater is not braced and utility connections are rigid pipe.

Details 1 and 2 show two different existing exterior wall details for a Model A dwelling. Reference circles have been superimposed onto these details showing the area of the wall where seismic deficiencies normally occur. The details for improvements to strengthen these deficiencies are found in Chapter 6. Table 1 and the additional details in Chapters 6 and 7 also recommend other improvements, although not illustrated in these exterior wall details.
Model B
Single Story, Double Wythe Brick
with Basement and Attic

Model B was built in the late 1890s, and is a single-story home with an attic area used for living space, with a concrete shelf type basement (figures 29 and 30). The construction consists of double wythe URM exterior walls, concrete foundation walls supporting a wood floor, roof/ceiling joists around the exterior, wood post and beams inside the dwelling, the front and back porch roofs are supported by wood posts, and it has one exterior chimney. Some of the posts are bearing on masonry piers.

The seismic deficiencies observed in Model B are:

1. The lack of anchorage of the roof to the URM exterior walls. There may or may not be a wood plate on top of the typical URM wall which this home did not have.

2. The lack of anchorage of the floor to the URM and concrete foundation walls.

3. The chimney is not braced.

4. The lack of continuous sheathing makes the roof diaphragm weak. There are 1 x 8 inch wood boards spaced at approximately 12 inches on center.

5. The concrete foundation wall has deteriorated. The vertical concrete walls in the basement of this dwelling do not extend to the floor structure and are walls of the shelf basement. While these interior concrete walls may also be deteriorating, it is typically more important that the actual foundation walls be strengthened first.

6. The interior wood post and beam line is not anchored to the floor and roof.

7. The masonry bearing walls are unreinforced.

8. The wood posts are not braced or adequately attached to the porch roof, there is a weak connection from the posts to the piers below, and the piers have deteriorated. The occupied attic consists of unanchored wood stud walls between the ceiling and roof joists.

9. The water heater is not braced and utility connections are rigid pipe.

Details 3 and 4 show two different existing wall details for Model B. Reference circles have been superimposed onto these details showing the area of the wall where seismic deficiencies normally occur. The details for improvements to strengthen these deficiencies are found in Chapter 6. Table 1 and the additional details in Chapters 6 and 7 also recommend other improvements, although not illustrated in these exterior wall details.
Model C
Two Story, Stucco-Covered Double Wythe Brick with Shelf Basement

Model C was built in the 1900s, and is a two-story home with a concrete shelf basement (figures 31 and 32). The construction consists of double wythe URM exterior walls covered with stucco, masonry/rock foundation walls supporting a wood floor and roof/ceiling joists around the exterior. A wood beam on masonry piers or wood posts supports the floor, while a wood stud wall supports the roof. It has two exterior chimneys and several small roof areas built into the dwelling.

The seismic deficiencies observed in Model C are:

1. The lack of anchorage of the roof to the URM exterior walls. There may or may not be a wood plate on top of the typical URM wall which this home did not have. The small areas at the front entrances are also not anchored.
2. The lack of anchorage of the floor to the URM exterior and concrete foundation walls.
3. The chimneys are not braced.
4. The lack of continuous sheathing makes the roof diaphragm weak. There are 1 x 8 inch wood boards spaced at approximately 12 inches on center.
5. The masonry/rock foundation walls have deteriorated.
6. The masonry bearing walls are unreinforced.
7. The interior wood stud bearing walls are not anchored to the floor or roof.
8. The water heater is not braced and utility connections are rigid pipe.

Details 5 and 6 show two different existing exterior walls sections for Model C. Reference circles have been superimposed onto the details showing the area of the wall where seismic deficiencies normally occur. The details for improvements to strengthen these deficiencies are found in Chapter 6. Table 1 and the additional details in Chapters 6 and 7 also recommend other improvements, although not illustrated in these exterior wall details.
Model D
Two Story, Double Wythe Brick with Shelf Basement and Attic

Model D was built in the early 1900s and is a two-story home with living space built into the attic area and a partial shelf basement (figures 33 and 34). The construction consists of double wythe URM exterior walls and masonry/rock foundation walls supporting a wood floor and roof/ceiling joists around the exterior. A wood beam supported by masonry piers support the floor, while an interior wood stud wall supports the ceiling/floor joists. It usually has one exterior chimney and may have low roof areas at any elevated the floor levels.

The seismic deficiencies observed in Model D are:

1. The lack of anchorage of the roof to the URM exterior walls. There may or may not be a wood plate on top of the typical URM wall which this home did not have.
2. The lack of anchorage of the floor to the URM exterior and concrete foundation walls.
3. The chimneys are not braced.
4. The lack of continuous sheathing makes the roof diaphragm weak. There are 1x8 inch wood boards spaced at approximately 12 inches on center.
5. The masonry/rock foundation walls are often deteriorated.
6. The masonry bearing walls are unreinforced.
7. The interior wood stud bearing walls are not anchored to the floor or roof, the connection of the beam line to the piers is inadequate, and the masonry pier is often deteriorated.
8. The water heater is not braced and utility connections are rigid pipe.

Details 7 and 8 show two different existing exterior wall sections for Model D. Reference circles have been superimposed into these details showing the area of the wall where seismic deficiencies normally occur. The details for improvements to strengthen these deficiencies are found in Chapter 6. Table 1 and the additional details in Chapters 6 and 7 also recommend other improvements, although not illustrated in these exterior wall details.
Model E

Single Story, Single Wythe Solid Brick with Full Basement

Model E was built in approximately 1966, and is single-story home with a full basement and a low slope roof (figures 35 and 36). The construction consists of single wythe URM exterior walls and concrete foundation walls supporting wood floor joists and roof trusses around the exterior with wood stud bearing walls supporting the interior. The roof structure extends over the carport and changes from trusses to sloped joists supported by wood beams at the ridge and ends. The end beams are carried by steel or wood columns.

The seismic deficiencies observed in Model E are:

1. The lack of anchorage of the roof to the URM exterior walls.
2. The lack of anchorage of the floor to the URM exterior and concrete foundation walls.
3. The masonry bearing walls are unreinforced.
4. The beams and columns for the carport are not anchored or braced to the roof or to the masonry walls of the dwelling.
5. The interior wood stud bearing walls are not anchored to the floor or roof.
6. The water heater is not braced and utility connections are rigid pipe.

Details 9 and 10 show two different existing exterior wall sections for Model E. Reference circles have been superimposed into these details showing the area of the wall where seismic deficiencies normally occur. The details for improvements to strengthen these deficiencies are found in Chapter 6. Table 1 and the additional details in Chapters 6 and 7 also recommend other improvements, although not illustrated in these exterior wall details.
Model F
Single Story, Concrete/Cinder Block with Basement and Flat Roof

Model F was built in 1954, and is a single-story home with a partial basement and flat roof (figure 37). The construction consists of a concrete/cinder block walls, referred as concrete masonry units (CMU), and concrete foundation walls supporting wood floor and roof/ceiling joists around the exterior with wood stud bearing walls supporting the interior. It has one low chimney with a metal flue that extends up. The roof over the front porch is supported by slender wood posts.

The seismic deficiencies observed in Model F are:
1. The lack of anchorage of the roof to the URM exterior walls.
2. The lack of anchorage of the floor to the URM exterior and concrete foundation walls.
3. The masonry bearing walls are unreinforced.
4. The interior wood stud bearing walls are not anchored to the floor or roof.
5. The support for the roof area over the porch is inadequate to transfer the lateral forces.
6. The water heater is not braced and utility connections are rigid pipe.

Detail 11 shows an existing exterior wall section for Model F. Reference circles have been superimposed into this detail showing the area of the wall where seismic deficiencies normally occur. The details for improvements to strengthen these deficiencies are found in Chapter 6. Table 1 and the additional details in Chapters 6 and 7 also recommend other improvements, although not illustrated in these exterior wall details.

Model G
Single Story, Concrete/Cinder Block with Brick Veneer and Full Basement with Flat Roof

Model G is a single-story home with a basement and was a common building type constructed in the 1940s and 1950s (figure 38). The construction consists of CMU walls with exterior brick veneer and concrete foundation walls with the concrete/cinder block portion of the exterior walls supporting wood floor and roof/ceiling joists around the exterior with wood stud bearing walls supporting the interior. The roof is framed with two (2x) members for a sloped roof or later dated dwellings may be constructed with trusses. It usually has a low chimney with a metal flue that extends upward. The roof over the front porch is supported by slender wood posts or masonry piers.

The seismic deficiencies observed in Model G are:
1. The lack of anchorage of the roof to the URM exterior walls.
2. The lack of anchorage of the floor to the URM exterior and concrete foundation walls.
3. The masonry bearing walls are unreinforced.
4. The interior wood stud bearing walls are not anchored to the floor or roof.
5. The support for the roof area over the porch is inadequate to transfer the lateral forces.
6. The water heater is not braced and utility connections are rigid pipe.

Details 12 and 13 show different existing exterior wall sections for Model G. Reference circles have been superimposed into these details showing the areas of the wall where seismic deficiencies normally occur. The details for improvements to strengthen these deficiencies are found in Chapter 6. Table 1 and the additional details in Chapters 6 and 7 also recommend other improvements, although not illustrated in these exterior wall details.

**Special Features**

Special features are those structural elements that are not typically present in all URM dwellings. This section will address four of the more common special features.

**Parapets**

A parapet is the portion of a wall that projects above the roofline and the top of a typical parapet is usually not braced (figure 39). When an earthquake occurs, the parapet can break off near the roofline from seismic forces. The bottom of the parapet near the roofline is normally a weak zone because roof joists and other framing members are pocketed into the wall at this location. Failure of parapets can create a falling hazard that is a serious life safety concern, especially over doorways and walkways. As a general rule, the higher the parapet, the more serious the hazard. Details at the end of this chapter show how to help strengthen this deficiency.

**Gable End Walls**

A gable end wall is the triangle section of an exterior wall under the roof plane and above the eaves line (figure 40). This portion of a typical URM wall is not normally braced and supports the roof ridge. The height of this wall and the unbraced condition make it less stable than other elements to resist out-of-plane forces. Out-of-plane failure of a gable end wall is similar to that described for URM walls. The size of the gable end wall and the intensity and direction of seismic forces will have a direct effect on the stability of the wall. A wide gable generally supports a large portion of the roof. Failure of this type of gable end wall is likely to also result in at least partial collapse of the roof. The roof...
rafters adjacent to a tall narrow gable are usually designed to bear on the main walls below. Failure of this type of gable end wall could create a falling hazard similar to parapets, but collapse of the roof is not likely unless the main walls below also fail. See detail 21 to help strengthen this deficiency.

Chimneys

Almost every URM home has one or more chimneys. A chimney can be located on an exterior wall or within the interior of a dwelling (figure 41). The roof joists may be pocketed into the side of the chimney or headered off around it. Often, chimneys are corbelled out of the top of a wall for a flue connection to a stove or furnace. The failure of chimneys is very similar to that of parapets. See details 22 through 25 to help strengthen these deficiencies.

Corner Windows

A corner window usually has a steel pipe at the outside corner of the window under a steel lintel to support the masonry wall above or the wall above may be on a cantilevered steel angle to avoid a corner post (figure 42). When used, the steel pipe may or may not be connected to the steel lintel. This feature may create a weakness in the shear wall. If the steel pipe was to become displaced, partial collapse of the dwelling could take place. See details 26 and 26a to help strengthen this deficiency.
Model Type Description and Wall Details

Wall section details to show areas of potential seismic deficiencies (Details 1-19)*

**Model A: Details 1-2**
Single story, double wythe brick with basement

**Model B: Details 3-4**
Single story double wythe brick with shelf basement and attic

**Model C: Details 5-6**
Two story, stucco-covered double wythe brick with shelf basement and attic

**Model D: Details 7-8**
Two story, double wythe brick with shelf basement and attic

**Model E: Details 9-10**
Single story, single wythe, solid brick with full basement

**Model F: Detail 11**
Single story concrete/cinder block (CMU) with basement and flat roof

**Model G: Details 12-13**
Single story concrete/cinder block (CMU) with brick veneer and full basement

*Unused detail numbers are intentionally left out for future additions.*
Model A: Details 1–2
Single story, double wythe brick with basement
SECTION W/ JOIST FRAMING PARALLEL TO WALL

<table>
<thead>
<tr>
<th>Model Home Seismic Deficiencies</th>
<th>HOME TYPE: MODEL A</th>
<th>Exterior Wall Sections</th>
<th>DETAIL: 2</th>
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</table>
Model B: Details 3–4
Single story double wythe brick with shelf basement and attic
SECTION W/ JOIST FRAMING PARALLEL TO WALL

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<tbody>
<tr>
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Model C: Details 5–6
Two story, stucco-covered, double wythe brick with shelf basement and attic

SECTION W/ JOIST FRAMING PERPENDICULAR TO WALL
SECTION W/ JOIST FRAMING PARALLEL TO WALL

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<th>Exterior Wall Sections</th>
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- ROOF SHEATHING
- ROOF JOIST
- CEILING JOIST
- FASCIA SHEATHING AT GABLE END WALL
- FASCIA FRAMING
- EXISTING STUCCO COVERING
- URM MULTI-WYTHE WALL
- FLOOR SHEATHING
- FLOOR JOISTS
- FLOOR BEAM (BEYOND)
- CONCRETE SHELF AND WALL

- FLOOR 53
- FLOOR 54
- EXTERIOR GRADE
- MASONRY/ROCK FOUNDATION WALL
Model D: Details 7–8
Two story, stucco-covered, double wythe brick with shelf basement and attic

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<td>MODEL D</td>
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**SECTION W/ JOIST FRAMING PERPENDICULAR TO WALL**

- **32 ROOF**
- **32a ROOF** OR **32b ROOF**
- **50 FLOOR**
- **51 FLOOR**
- **MASONRY/ROCK FOUNDATION WALL**
- **EAVE SHEATHING**
- **CEILING JOIST**
- **URM MULTI-WYTHE WALL**
- **FLOOR SHEATHING**
- **FLOOR JOISTS**
- **CONCRETE SHELF AND WALL**
SECTION W/ JOIST FRAMING PARALLEL TO WALL
Model E: Details 9–10
Single story, single wythe, solid brick with full basement

SECTION W/ JOIST FRAMING PERPENDICULAR TO WALL

| Model Home Seismic Deficiencies | HOME TYPE: MODEL E | Exterior Wall Sections | DETAIL: 9 |
SECTION W/ JOIST FRAMING PARALLEL TO WALL

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Diagram: ROOF SHEATHING, ROOF TRUSS, URM SINGLE WYTHE WALL, FLOOR SHEATHING, FLOOR JOISTS, CONCRETE FOUNDATION WALL, CONCRETE SLAB ON GRADE, CONCRETE FOOTING.
**Model F: Detail 11**

Single story concrete/cinder block (CMU) with basement and flat roof

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**Diagram: Section W/ Joist Framing Perpendicular To Wall**

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<thead>
<tr>
<th>Model Home Seismic Deficiencies</th>
<th>HOME TYPE: MODEL F</th>
<th>Exterior Wall Sections</th>
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Model G: Details 12–13

Single story concrete/cinder block (CMU) with brick veneer and full basement

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SECTION W/ JOIST FRAMING PERPENDICULAR TO WALL

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<th>HOME TYPE: MODEL G</th>
<th>Exterior Wall Sections</th>
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CHAPTER 6

Seismic Mitigation of URM Structures

Chapter 6 contains conceptual structural details for corrective measures to improve common seismic deficiencies in the typical URM dwelling. The details are intended for general use and may be adapted to similar conditions with some minor modifications. The details have been drawn with continuous lines that are darker for new construction and text and slightly lighter lines to represent existing materials and conditions. Digital files for the details are available at the USSC website (https://ussc.utah.gov).

The mitigation details in this guide are designed for use by a homeowner with some construction experience or a small contractor. A homeowner who is comfortable with using power tools and has a general understanding of how their dwelling is built may feel that a contractor is not necessary. This can be a “do-it-yourself” task for homeowners who have a reasonable amount of knowledge in construction methods and materials. We recommend the use of a contractor for that portion of the project that the homeowner determines is beyond their individual capacity, knowledge, and experience. In all cases, we recommend that the homeowner or contractor involved seek additional help and/or consult a Utah-licensed Professional Engineer or Architect if there is any reason for concern. Improper work often creates difficulties or weakness with the dwelling that can be expensive to correct. For each seismic improvement measure selected, there will normally be several potential mitigation details from which to choose, but the specific method chosen will be up to the homeowner. Always check with your local municipality or county for building permit or other requirements that apply to your project.

The details in this chapter are designed to show structural elements and are not intended to provide procedures for product preparation and installation or the removal and replacement of existing materials, such as finishes. Manufacturers normally provide preparation and installation procedures for their products, but seldom cover the removal or replacement of existing materials. The techniques required to removing existing finishes for the purpose of gaining access to the work area and the replacement of these materials after the work is completed will vary with each specific dwelling. The homeowner will have to develop individual procedures for the removal and replacement of these materials. Explanations of construction procedures are not provided in this guide.

The following items are important considerations for the homeowner when a decision is made to proceed with a seismic improvement project of a dwelling.

Tools

A list of tools required to carry out the project(s) using the selected retrofit details.

- Do you own them?
- Can you borrow them?
- Do you want to purchase or rent them? If purchased or rented, this cost should be added to total project cost.

Cost

- A cost estimate for work contracted will be provided by the contractor performing the work.
- The cost estimate for work performed by the homeowner can be compiled from contacting home improvement stores, lumberyards, suppliers, etc. We recommend adding 20% to 30% of the total project cost for contingency (unexpected) items.

Disruption of Lifestyle

The degree of disruption will differ with each seismic improvement measure. The room(s) surrounding the construction may become unusable for a period of time. Rooms that must remain in use will likely have dust and debris present. Whenever a project is undertaken within an occupied space, it will almost always take longer and cost more than anticipated. The length of time will also vary according to the procedure, experience, and the amount of time the homeowner can devote to the project while still meeting other obligations, such as a job, family, etc.
Construction Considerations

Access to a specific area where seismic improvement measures are to take place can be difficult at times. Some planning should be done prior to proceeding with the project to determine where access to each work area will take place.

Physical work can vary from being stooped over at ground level for a long period of time to standing on a tall ladder working overhead. Work may also include crawling in basements (some with very limited heights) or climbing into cramped attic spaces with loose, dusty insulation. Any area that is not a finished, usable space may contain insects and/or rodents. Anyone with phobias relating to these issues should give strong consideration to hiring a Utah-licensed contractor to perform the job.

Safety

A complete understanding of the work and the ability to operate various tools is mandatory. Improper use of any tool can cause serious injury. Fall hazards and all other real or potential hazards should be investigated and avoided. Personal protective equipment (goggles, respirators, gloves, etc.) should be used at all times. Anytime asbestos or other hazardous materials are suspected, the homeowner should have tests taken immediately by appropriately experienced and Utah-licensed professionals to determine the magnitude of the problem and advise how to proceed. Safety should always be the primary concern, as no improvement to a dwelling is worth the cost of a debilitating injury or death.

Each seismic improvement measure that is to be implemented must be reviewed and analyzed to determine all of the steps that will be required to complete the work. The homeowners must examine their individual ability and decide whether it is a do-it-yourself job, a hired contractor project, or a combination of both. If a contractor is needed, before selecting: check references, licensing (http://dopl.utah.gov/licensing/contracting.html), and the Better Business Bureau (http://www.bbb.org/utah/).

The various details within this guide have limited information on fasteners and connectors for the products called out in the details with most noted in a generic method to avoid the appearance of recommending one manufacturer or supplier over another. Many manufacturer and supplier products are available and many of these products are acceptable alternatives. A thorough comparison should always be made to ensure that the materials, strengths, and capacities are equal to or better than the products that are noted in the details.

The following details are intended to show basic concepts for generic use with the various model dwelling types and may apply to similar conditions of several model types. If these details do not match the existing conditions of any existing dwelling or if there is any confusion or misunderstanding about how to apply a particular detail, the homeowner is encouraged to contact a Utah-licensed Professional Structural Engineer for consultation.
Individual Structural Repair Details
Details for seismic mitigation of URM structures

(Details 20–99)*

**Structural bracing: Details 20–26a**

**Roof anchorage and strengthening: Details 30–41**

**Floor anchorage and strengthening: Details 50–57**

**Wall strengthening: Details 70–82**

**Foundation anchorage and strengthening: Detail 90**

*Unused detail numbers are intentionally left out for future additions.*
Structural bracing: Details 20–26a

- **GALVANIZED PLATE WASHER - EMBED INTO BEAD OF SEALANT**
- **L3x3x1/4” W 3/4” DIA. THRU BOLT, OR RUN ANGLE CONTINUOUS W/ BOLTS AT 48” O.C.**
- **L2x2x3/16” AT 48” O.C. W/ 3/4” DIA BOLT EACH END**
- **WEATHER PROOF ROOF PENETRATIONS AS REQUIRED BY MANUFACTURER OF ROOFING SYSTEM**
- **FRAMING ANCHOR EACH END**
- **2x BLKG BETWEEN JOISTS**
- **TENSION STRAP TIE NAILS AS REQUIRED BY THE MANUFACTURER**

**NOTE:**
ALL EXPOSED STEEL SHALL BE GALVANIZED OR PROTECTED BY A HIGH QUALITY COATING

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>Home Type: Varies</th>
<th>Structural Bracing</th>
<th>Detail: 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARAPET BRACING</td>
<td></td>
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</tbody>
</table>
SEISMIC/HURRICANE TIE AT EACH JOIST EACH SIDE

2x8 CONT. W/ 3/4" DIA THRU BOLT AT 48" O.C.

TENSION TIE STRAP W/ 3/4" DIA
THRU BOLT AT 48" O.C. AT WALL

2x8x30" LONG W/ (3) FRAMING ANCHORS AT JOIST

(2) 2X4 BRACE AT 48" O.C. MAX
W/ FRAMING ANCHOR AT BOTTOM
3-10d NAILS AT TOP
10d NAILS AT 6" O.C.

PROVIDE 2X4 ONLY WHEN "L" IS GREATER THAN 48"

LTB STRAP OR SIMILAR

2X6 CONT. W/ 3/4" DIA THRU BOLT AT 48" O.C.

EXISTING CEILING FRAMING

GALVANIZED PLATE WASHER
EMBED INTO BEAD OF SEALANT

EXISTING MASONRY GABLE

URM GABLE BRACING

<table>
<thead>
<tr>
<th>Seismic Improvement</th>
<th>HOME TYPE:</th>
<th>Structural Bracing</th>
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<td>Structural Detail</td>
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SECTION A–A

3"x1/4" PLATE STRAP W/ 3/4" DIA THRU BOLT W/ WASHER

EXISTING ROOF STRUCTURE

WEATHER PROOF ROOF PENETRATIONS AS REQUIRE BY MANUFACTURER OF ROOFING SYSTEM

NEW FRAMING ANCHORS EACH END

NEW 2x HEADER AT EACH BRACE BETWEEN ROOF JOISTS W/ FRAMING ANCHOR EACH END

NEW HORIZONTAL 2x BRACE AT EACH SIDE OF CHIMNEY W/ FRAMING ANCHORS EACH END

EXISTING INTERIOR CHIMNEY

NOTE:
ALL EXPOSED STEEL SHALL BE GALVANIZED OR PROTECTED BY A HIGH QUALITY COATING

INTERIOR CHIMNEY BRACING
W/ HEADER AT JOIST

Seismic Improvement Structural Detail | HOME TYPE: VARIES | Structural Bracing | DETAIL: 22
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

3"x1/4" PLATE STRAP W/ 3/4" DIA THRU BOLT EACH END

GALVANIZED PLATE WASHER – EMBED INTO BEAD OF SEALANT

EXISTING FRAMING

HOLD DOWN ANCHOR

STRAP TIE ACROSS JOIST AT TOP OR BOTTOM AT NEW BLOCKING

NOTE:
ALL EXPOSED STEEL SHALL BE GALVANIZED OR PROTECTED BY A HIGH QUALITY COATING

REMOVE & REPLACE CEILING AS REQUIRED

EXISTING MASONRY CHIMNEY

EXISTING MASONRY WALL

NEW 2x SOLID BLOCKING W/ FRAMING ANCHORS EACH END – EXTEND BLOCKING (2) JOIST SPACES

SECTION A-A

24
BRACE
EXTERIOR CHIMNEY TO FLOOR ANCHORAGE
@ JOISTS PARALLEL TO WALL

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE:</th>
<th>STRUCTURAL BRACING</th>
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<td>structural</td>
<td>24</td>
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</tbody>
</table>
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SECTION A-A

TYPICAL

L3x3x\(\frac{3}{16}\) ANGLE OR 2” DIA STD. STEEL PIPE BRACE W/ 3/4” DIA THRU BOLT EACH END

L3x3x\(\frac{3}{16}\)x4” W/ 3/4” DIA THRU BOLT

WEATHER PROOF ROOF PENETRATIONS AS REQUIRED BY MANUFACTURER OF ROOFING SYSTEM

3”x1/4” PLATE STRAP

EXISTING ROOF STRUCTURE

41
ROOF

SOLID 4x4 BLOCKING BETWEEN JOISTS FRAMING ANCHOR EACH END

EXISTING INTERIOR CHIMNEY

NOTE:
ALL EXPOSED STEEL SHALL BE GALVANIZED OR PROTECTED BY A HIGH QUALITY COATING

25
EXTERIOR CHIMNEY TO ROOF ANCHORAGE

<table>
<thead>
<tr>
<th>Seismic Improvement</th>
<th>HOME TYPE</th>
<th>Structural Detail</th>
<th>Structural Bracing</th>
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<td>Structural Detail</td>
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<td>25</td>
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</table>
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS
INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION
TO AVOID FRACTURE OF WALLS AND THE RESULTING
INCREASED REPAIR EFFORT AND COST.

EXISTING STEEL PLATE
OR ANGLES

NOTE:
REMOVE EXISTING WINDOWS,
SHORE UP WALL ABOVE
WINDOW, REMOVE CORNER
PIPE COLUMN & REPLACE
W/ NEW CORNER COLUMN.
REPLACE WINDOWS.

NEW STEEL TUBE COLUMN W/
BASE PLATE & CAP PLATE.
CONSULT AN ENGINEER
FOR REQUIRED SIZE

(2) NEW HELICAL
MECHANICAL ANCHORS
TOP AND BOTTOM,
CLINCHED

EXISTING MASONRY
WALL

NOTE:
ALL EXPOSED STEEL SHALL BE
GALVANIZED OR PROTECTED BY
A HIGH QUALITY COATING

CORNER WINDOW STRENGTHENING

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<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE:</th>
<th>Varies</th>
<th>Structural Bracing</th>
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<th>26</th>
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</table>
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

NOTE:
REMOVE EXISTING WINDOWS, SHORE UP WALL ABOVE WINDOW, REMOVE CORNER PIPE COLUMN & REPLACE W/ NEW CORNER COLUMN. REPLACE WINDOWS.

NEW STEEL TUBE COLUMN W/ BASE PLATE & CAP PLATE. CONSULT AN ENGINEER FOR REQUIRED SIZE.

NEW 3/4" DIA THREADED ROD IN EPOXY FILLED SCREEN TUBE TOP AND BOTTOM

EXISTING MASONRY WALL

NOTE:
ALL EXPOSED STEEL SHALL BE GALVANIZED OR PROTECTED BY A HIGH QUALITY COATING

CORNER WINDOW STRENGTHENING

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE:</th>
<th>STRUCTURAL BRACING</th>
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<td></td>
<td>VARIES</td>
<td></td>
<td>26a</td>
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</table>
Roof anchorage and strengthening: Details 30–41

NOTE:
FOR EASE OF INSTALLATION THE NEW WOOD MEMBERS CAN BE ASSEMBLED ON THE GROUND, LIFTED INTO PLACE AND THEN ATTACHED TO THE EXISTING WALL AND FRAMING.
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

NOTE:
FOR EASE OF INSTALLATION THE NEW WOOD MEMBERS CAN BE ASSEMBLED ON THE GROUND, LIFTED INTO PLACE AND THEN ATTACHED TO THE EXISTING WALL AND FRAMING.

ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>Home Type Model A</th>
<th>Roof to URM Wall Anchorage</th>
<th>Detail</th>
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<td>30a</td>
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</table>
REMOVE AND REPLACE EXISTING ROOF SHEATHING W/ NEW WOOD SHEATHING
BOUNDARY EDGE NAILING
NEW STRAP TIE

NEW FRAMING ANCHOR EACH SIDE OF NEW BLOCKING
16d NAILS @ 6" O.C.
EXISTING FRAMING

NEW 2x4 PRESSURE TREATED BLOCKING BETWEEN EXISTING TRUSSES
EXISTING TOP PLATE
(2) HELICAL MECHANICAL ANCHORS IN EXISTING TOP PLATE @ 24" O.C. MAX. IN EACH WYTHE
EXISTING MASONRY WALL

NOTE:
FOR EASE OF INSTALLATION THE NEW WOOD MEMBERS CAN BE ASSEMBLED ON THE GROUND, LIFTED INTO PLACE AND THEN ATTACHED TO THE EXISTING WALL AND FRAMING.

31
ROOF

ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL

<table>
<thead>
<tr>
<th>Seismic Improvement</th>
<th>HOME TYPE</th>
<th>MODEL B</th>
<th>Roof to URM Wall Anchorage</th>
<th>DETAIL</th>
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<tr>
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<td>31</td>
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</table>
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

SEE DETAIL FOR EXISTING CONDITION

NOTE:
FOR EASE OF INSTALLATION THE NEW WOOD MEMBERS CAN BE ASSEMBLED ON THE GROUND, LIFTED INTO PLACE AND THEN ATTACHED TO THE EXISTING WALL AND FRAMING.

ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: MODEL B</th>
<th>Roof to URM Wall Anchorage</th>
<th>DETAIL: 31a</th>
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</thead>
</table>
PROVIDE VENT HOLES AS NEEDED
1" CLEAR

NEW STRAP TIE
EXISTING FRAMING
NEW FRAMING ANCHOR

SEE DETAIL FOR
EXISTING CONDITION

SECTION A–A

REMOVE AND REPLACE EXISTING ROOF SHEATHING
W/ NEW WOOD SHEATHING

BOUNDARY EDGE NAILING

NEW 2x SHAPED BLOCKING BETWEEN EACH ROOF JOIST

NEW FRAMING ANCHOR
EACH SIDE, EXISTING FRAMING TO NEW BLOCKING

NEW FRAMING ANCHOR
EXISTING FRAMING

NEW 2x SOLID PRESSURE TREATED BLOCKING TO MATCH WIDTH OF WALL BETWEEN JOIST W/ (2) HELICAL MECHANICAL ANCHORS IN EACH BLOCKING PIECE, CLINCHED AT TOP

EXISTING MASONRY WALL

ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL

Seismic Improvement Structural Detail | HOME TYPE: MODEL C & D | Roof to URM Wall Anchorage | DETAIL: 32
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

SECTION A-A

PROVIDE VENT HOLES AS NEEDED 1" CLEAR

NEW STRAP TIE
EXISTING FRAMING
NEW FRAMING ANCHOR

REMOVE AND REPLACE EXISTING ROOF SHEATHING W/ NEW WOOD SHEATHING
BOUNDARY EDGE NAILING

NEW 2x SHAPED BLOCKING BETWEEN EACH ROOF JOIST

NEW FRAMING ANCHOR EACH SIDE, EXISTING FRAMING TO NEW BLOCKING

SEE DETAIL 5 & 7 SECTION
FOR EXISTING CONDITION

EXISTING FRAMING

NEW 2x6 SOLID PRESSURE TREATED BLOCKING BETWEEN JOIST W/ ¾" DIA. THREADED ROD W/ WASHER IN EPOXY FILLED SCREEN TUBE @ 48" O.C. MAX.

EXISTING MASONRY WALL

NOTE: DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL

Seismic Improvement Structural Detail  HOME TYPE: MODEL C & D  Roof to URM Wall Anchorage  DETAIL: 32a
Remove and replace existing roof sheathing with new wood sheathing.

Boundary edge nailing.

New 2x shaped blocking between each roof joist.

New flat framing anchor.

3/4" dia. thru bolt @ 48" O.C. max.

1/4" x 6" min galvanized plate washer or steel band-embed into bead of sealant.

New framing anchor each side, existing framing to new blocking.

16d nails @ 6" O.C.

Existing framing.

New 2x solid pressure treated blocking between joist.

Visqueen or metal flashing water barrier between lvl and brick.

Existing masonry wall.

Roof to URM wall anchorage w/ joists perpendicular to wall.

Seismic Improvement Structural Detail | Home Type Model C & D | Roof to URM Wall Anchorage | Detail 32b
SECTION A-A

NEW FRAMING ANCHOR

NEW STRAP TIE

EXISTING FRAMING

1" CLEAR

PROVIDE VENT HOLES

NEW FRAMING ANCHOR

REMOVE AND REPLACE EXISTING ROOF SHEATHING W/ NEW WOOD SHEATHING

BOUNDARY EDGE NAILING

NEW 2x SHAPED BLOCKING BETWEEN EACH ROOF JOIST

NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

EXISTING MASONRY WALL

NEW 2x6 SOLID PRESSURE TREATED BLOCKING BETWEEN JOIST W/ 3/4" DIA. THREADED ROD W/ WASHER IN EPOXY FILLED SCREEN TUBE @ 48" O.C. MAX. IN GROUTED CELL, OR SET BOLT DIRECTLY INTO NEWLY GROUTED CELL

EXISTING FRAMING

NEW FRAMING ANCHOR EACH SIDE, EXISTING FRAMING TO NEW BLOCKING

SEE DETAIL FOR EXISTING CONDITION

SECTION 12

ROOF

A

A

12" MIN.

32c ROOF

ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL

Seismic Improvement Structural Detail MODEL G Roof to URM Wall Anchorage DETAIL: 32c
PROVIDE VENT HOLES

1" CLEAR
NEW TIE STRAP
EXISTING FRAMING
AND EAVE TAILS

NEW FRAMING ANCHOR
NEW FRAMING ANCHOR

SECTION A-A

REMOVE AND REPLACE
EXISTING ROOF SHEATHING
W/ NEW WOOD SHEATHING
BOUNDARY EDGE NAILING

NEW OR EXISTING
2X BLOCKING

EXISTING 2X WOOD PLATE

(2) NEW CLINCHED HELICAL
MECHANICAL ANCHORS
PER BLOCKING PIECE

SEE DETAIL
FOR EXISTING
CONDITION

41
ROOF

12" MIN.

A

33
ROOF

ROOF TO URM WALL ANCHORAGE W/
JOISTS PERPENDICULAR TO WALL

Seismic Improvement
Structural Detail

HOME TYPE:
MODEL E

Roof to URM Wall Anchorage

DETAIL: 33
SECTION A–A

REMOVE AND REPLACE EXISTING ROOF SHEATHING W/ NEW WOOD SHEATHING
BOUNDARY EDGE NAILING

NEW OR EXISTING 2X BLOCKING

EXISTING 2X WOOD PLATE

3/4" DIA. THRU BOLT @ 48" O.C. MAX.

1/4x6 MIN GALVANIZED PLATE WASHER OR STEEL BAND–EMBED INTO BEAD OF SEALANT

SEE DETAIL FOR EXISTING CONDITION

16D NAILS @ 6" O.C.
NEW 2X SOLID PRESSURE TREATED BLOCKING BETWEEN JOIST

NEW 1 3/4x11 3/8 LVL CONT.

VISQUEEN OR METAL FLASHING WATER BARRIER BETWEEN LVL AND BRICK

ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL

| Seismic Improvement Structural Detail | HOME TYPE: MODEL E | Roof to URM Wall Anchorage | DETAIL: 33a |
**SECTION A-A**

- **NEW FRAMING ANCHOR**
- **EXISTING FRAMING**
- **1" CLEAR**
- **PROVIDE VENT HOLES**
- **REMOVE AND REPLACE**
  - EXISTING ROOF SHEATHING
  - W/ NEW WOOD SHEATHING
  - BOUNDARY EDGE NAILING
- **NEW 2x SOLID BLOCKING**
  - BETWEEN EACH ROOF JOIST
  - W/(3) 10d TOE NAILS
  - AT EACH END OF EACH ROOF JOIST
- **EXISTING 2x WOOD PLATE**
- **NEW 3/4" DIA THREADED**
  - ROD W/ WASHER IN EPOXY FILLED SCREEN TUBES OR NEW 3/4" DIA. THREADED RODS IN NEWLY GROUTED CELLS,
  - W/RODS @ 48" O.C. MAX.
- **BREAKOUT FACE SHELL AS REQUIRED TO GROUT CELLS AT ANCHOR BOLT**
- **EXISTING URM CMU WALL**
- **NEW FRAMING ANCHOR EACH SIDE**

**ROOF TO URM WALL ANCHORAGE W/ JOISTS PERPENDICULAR TO WALL**

| Seismic Improvement Structural Detail | HOME TYPE: MODEL F | Roof to URM Wall Anchorage | DETAIL: 34 |
BOUNDARY EDGE NAILING
NEW 2x SHAPED VERTICAL @ 24" O.C.
NEW 10d NAILS @ 6" O.C. TO NEW BLOCKING
2x4 SOLID BLOCKING W/ 10d NAILS AT EACH END

2x4xCONT. W/ 10d
NEW 2x4 BRACE W/ FRAMING ANCHORS @ BOTTOM & (3) 10d NAILS AT TOP INTO BLOCKING @ 48" O.C. MAXIMUM

EXISTING EAVE PORCH FRAMING
EXISTING EAVE/PORCH SHEATHING. REMOVE & REPLACE AS REQUIRED
EXISTING MASONRY WALL

NEW 7/16" OSB SHEATHING W/ 8d NAILS @ 4" O.C. ALL EDGES AND VERTICALS UNLESS NOTED OTHERWISE

DRILL 2" DIA VENT HOLES AS REQUIRED
EXISTING FRAMING

EXISTING CEILING, REMOVE & REPLACE AS REQUIRED. ALTERNATE ACCESS MAY BE THRU ROOF OR EAVE OVER PORCH
NEW 16d NAILS @ 4" O.C. INTO NEW 2x PLATE
NEW 2x PRESSURE TREATED PLATE TO MATCH WIDTH OF WALL W/ (2) HELICAL MECHANICAL ANCHORS IN EACH BLOCKING PIECE @ 16" O.C. MAX.

ROOF TO URM WALL ANCHORAGE W/ JOISTS PARALLEL TO WALL

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: MODEL A</th>
<th>Roof to URM Wall Anchorage</th>
<th>DETAIL: 35</th>
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SEE DETAIL FOR EXISTING CONDITION
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

NEW 2x SHAPE
VERTICAL @ 24" O.C.
NEW 10d NAILS
@ 6" O.C. TO NEW BLOCKING
2x4 SOLID BLOCKING
W/ 10d NAILS AT EACH END

BOUNDARY EDGE NAILING
NEW 7/8" OSB SHEATHING W/ 8d NAILS
@ 4" O.C. ALL EDGES AND VERTICALS UNLESS NOTED OTHERWISE

2x4 CONT. W/ 10d
NEW 2x4 Brace W/ FRAMING ANCHORS @ BOTTOM & (3) 10d NAILS AT TOP INTO BLOCKING @ 48" O.C. MAXIMUM

EXISTING CEILING, REMOVE & REPLACE AS REQUIRED. ALTERNATE ACCESS MAY BE THRU ROOF OR EVE OVER PORCH
NEW 16d NAILS
@ 4" O.C. INTO
NEW 2x PLATE
NEW 2x PRESSURE TREATED PLATE
W/ 3/4" DIA. THREADED ROD W/ WASHERS IN EPOXY FILLED SCREEN TUBE @ 48" O.C. MAX.

EXISTING EAVE PORCH FRAMING
EXISTING EAVE/PORCH SHEATHING, REMOVE & REPLACE AS REQUIRED
EXISTING MASONRY WALL

ROOF TO URM WALL ANCHORAGE W/ JOISTS PARALLEL TO WALL

| Seismic Improvement Structural Detail | HOME TYPE: MODEL A | Roof to URM Wall Anchorage | DETAIL: 35a |
**The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings**

- **2x4 SOLID BLOCKING**
  
  W/ (2) 10d NAILS AND FRAMING ANCHOR

- **BOUNDARY EDGE NAILING**

- **ADD NEW 2x4 VERT**
  
  AS REQUIRED FOR 24" O.C. SPACING

- **NEW 7/16" OSB SHEATHING**
  
  W/ 8d NAILS @ 4" O.C.
  
  ALL HORIZONTAL AND VERTICAL EDGES

- **NEW 2x4 BLOCKING W/**
  
  (2) 10d NAILS @ 4" O.C.

  PROVIDE FRAMING ANCHOR TO 2x4 VERTICAL AT EACH END

- **EXISTING 2x WOOD PLATE**

- **NEW 2x4 BRACE @**
  
  48" O.C. MAX. W/ (3) 10d NAILS AT EACH END

- **2x4xCONT. W/**
  
  10d NAILS

- **SLOT SHEATHING AROUND 2x4 BRACE**

- **EXISTING FRAMING**

- **EXISTING CEILING, REMOVE & REPLACE AS REQUIRED.**
  
  (ALTERNATE ACCESS MAY BE THRU ROOF)

- **(2) NEW CLINCHED HELICAL MECHANICAL ANCHORS IN EACH BLOCKING PIECE @ 16" O.C. MAX.**

- **EXISTING MASONRY WALL**

---

**ROOF TO URM WALL ANCHORAGE W/ JOISTS PARALLEL TO WALL**

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: MODEL B</th>
<th>Roof to URM Wall Anchorage</th>
<th>DETAIL: 36</th>
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</table>

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NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

2x4 SOLID BLOCKING
W/ (2) 10d NAILS
AND FRAMING ANCHOR

BOUNDARY EDGE NAILING

ADD NEW 2x4 VERT AS REQUIRED FOR 24” O.C. SPACING

NEW 3/16” OSB SHEATHING W/ 8d NAILS @ 4” O.C.
ALL HORIZONTAL AND VERTICAL EDGES

NEW 2x4 BLOCKING W/
(2) 10d NAILS @ 4” O.C.
PROVIDE FRAMING ANCHOR TO 2x4 VERTICAL AT EACH END

EXISTING 2x WOOD PLATE

NEW 2x4 BRACE @ 48” O.C. MAX.
W/ (3) 10d NAILS AT EACH END

2x4xCONT. W/ 10d NAILS
SLOT SHEATHING AROUND 2x4 BRACE
EXISTING FRAMING

EXISTING CEILING, REMOVE & REPLACE AS REQUIRED. (ALTERNATE ACCESS MAY BE THRU ROOF)

3/4” DIA. THREADED ROD W/ WASHERS IN EPOXY FILLED SCREEN TUBE @ 48” O.C. MAX.
EXISTING MASONRY WALL

ROOF TO URM WALL ANCHORAGE W/ JOISTS PARALLEL TO WALL

Seismic Improvement Structural Detail | HOME TYPE: MODEL B | Roof to URM Wall Anchorage | DETAIL: 36a
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

SEE DETAIL FOR EXISTING CONDITION

2x4 SOLID BLOCKING W/ (2) 10d NAILS AND FRAMING ANCHOR

BOUNDARY EDGE NAILING

ADD NEW 2x4 VERT AS REQUIRED FOR 24" O.C. SPACING

NEW 7/16" OSB SHEATHING W/ 8d NAILS @ 4" O.C. ALL HORIZONTAL AND VERTICAL EDGES

NEW 2x4 BLOCKING W/ (2) 10d NAILS @ 4" O.C. PROVIDE FRAMING ANCHOR TO 2x4 VERTICAL AT EACH END

EXISTING 2x WOOD PLATE

NEW 2x4 BRACE @ 48" O.C. MAX. W/ (3) 10d NAILS AT EACH END

2x4xCONT. W/ 10d NAILS

SLOT SHEATHING AROUND 2x4 BRACE

EXISTING FRAMING

EXISTING CEILING, REMOVE & REPLACE AS REQUIRED. (ALTERNATE ACCESS MAY BE THRU ROOF)

3/4" DIA. THREADED ROD W/ WASHERS IN EPOXY FILLED SCREEN TUBE @ 48" O.C. MAX. IN GROUTED CELL, OR SET BOLT DIRECTLY INTO NEWLY GROUTED CELL

EXISTING MASONRY WALL

36b ROOF TO URM WALL ANCHORAGE W/ JOISTS PARALLEL TO WALL

| Seismic Improvement Structural Detail | HOME TYPE: MODEL G | Roof to URM Wall Anchorage | DETAIL: 36b |
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

**ROOF TO URM WALL ANCHORAGE W/ JOISTS PARALLEL TO WALL**

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<th>HOME TYPE: MODEL C &amp; D</th>
<th>Roof to URM Wall Anchorage</th>
<th>DETAIL: 37</th>
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</table>
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

2x4 SOLID BLOCKING
W/ (2) 10d NAILS
AT EACH END

NEW 2x BLOCKING
BOUNDARY EDGE NAILING

ADD NEW 2x4 VERT
AS REQUIRED FOR
24” O.C. SPACING

REMOVE AND REPLACE WALL COVERING FOR ACCESS

NEW 2x4 PRESSURE TREATED BLOCKING W/
5/8” DIA ANCHOR BOLT
@ 32” O.C. PROVIDE FRAMING ANCHOR TO 2x4 VERTICAL EACH END

CONCRETE CAP W/ 3/4” DIA THREADED ROD @
32” O.C. IN EPOXY FILLED SCREEN TUBES & #4xCONT.
TOP & BOTTOM. INSTALL FLASHING BETWEEN CONCRETE AND SIDING MATERIALS

PROVIDE 1½x1¼x 20 GA.
CONTINUOUS METAL STUD AS SCREWING STRIP FOR INSTALL OF WALL COVERING

CLEAN BRICK PRIOR TO PLACING CONCRETE

NEW 2x4 BRACE @
48” O.C. MAX. W/
(3) 10d NAILS
AT EACH END

NEW 10d NAILS @ 6” O.C. TO NEW BLOCKING

2x4xCONT. W/ 10d NAILS

SLOT SHEATHING AROUND 2x4 BRACE

EXISTING FRAMING

EXISTING CEILING, REMOVE & REPLACE AS REQUIRED.

NEW ¾” OSB W/ 8d NAILS @ 4” O.C.
AT ALL HORIZONTAL AND VERTICAL EDGES VENT AS REQUIRED

EXISTING MASONRY WALL

37a ROOF TO URM WALL ANCHORAGE W/ JOISTS PARALLEL TO WALL

| Seismic Improvement Structural Detail | HOME TYPE: MODEL C | Roof to URM Wall Anchorage | DETAIL: 37a |
2x4 SOLID BLOCKING W/
(2) 10d NAILS AND
FRAMING ANCHOR
NEW 10d NAILS @ 6" O.C.
TO NEW BLOCKING
BOUNDARY EDGE NAILING

FRAMING ANCHOR FROM
EXISTING FRAMING TO
EXISTING WOOD PLATE
@ 24" O.C. MAX
NEW OR EXISTING 2x
WOOD PLATE
NEW HELICAL
MECHANICAL ANCHORS
IN EACH BLOCKING
PIECE @ 16" O.C. MAX

NEW 2x4 BRACE W/
FRAMING ANCHOR
EACH SIDE AT BOTTOM
AND (3) 10d NAILS
AT TOP
EXISTING FRAMING

2x4 CONT. W/
10d NAILS
EXISTING CEILING,
REMOVE & REPLACE
AS REQUIRED

NEW ¾" OSB
SHEATHING W/
8d NAILS @ 4" O.C.
ALL HORIZ AND
VERTICAL EDGES
VENT AS REQUIRED
EXISTING MASONRY
WALL

38 ROOF TO URM WALL ANCHORAGE W/
JOISTS PARALLEL TO WALL
ANCHOR BLOCKING OPTION #1
LESS THAN 11/4"

ANCHOR BLOCKING OPTION #2
11/4" TO 18"

EDGE BLOCKING OPTIONS AT
TRUSSED OR STICK FRAME ROOF

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: MODEL A &amp; B</th>
<th>Roof Diaphragm Strengthening</th>
<th>DETAIL</th>
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</table>
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

NEW EDGE NAILING (TYPICAL)

ANCHOR BLOCKING OPTION #1
LESS THAN 11\(\frac{1}{4}\)"

NEW EDGE NAILING (TYPICAL)

ANCHOR BLOCKING OPTION #2
11\(\frac{1}{4}\)" TO 18"

EDGE BLOCKING OPTIONS AT TRUSSED OR STICK FRAME ROOF

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>Home Type: Model A &amp; B</th>
<th>Roof Diaphragm Strengthening</th>
<th>Detail</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>39a</td>
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</table>
ANCHOR BLOCKING OPTION #3
MORE THAN 18"

NEW 2x4 SHAPED BLOCKING

NEW STRUCTURAL SHEATHING
NEW 8d NAILS @ 4" O.C. ALL SIDES OF SHEATHING
MORE THAN 18"
NEW 2x4 SHAPED VERTICAL EACH SIDE EACH TRUSS

PROVIDE VENT HOLES

NEW STRAP TIE EXISTING FRAMING
(4) NEW 10d NAILS AT EACH VERTICAL EACH SIDE OF TRUSS
NEW FRAMING ANCHOR EACH SIDE

SECTION A-A

EDGE BLOCKING OPTIONS
AT TRUSSED ROOF

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: MODEL A &amp; B</th>
<th>Roof Diaphragm Strengthening</th>
<th>DETAIL</th>
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<tbody>
<tr>
<td>40 ROOF</td>
<td></td>
<td></td>
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</table>
NOTE:
DRILLING AND PLACEMENT OF VERTICAL EPOXY BOLTS INTO URM WALLS MUST BE DONE WITH EXTREME CAUTION TO AVOID FRACTURE OF WALLS AND THE RESULTING INCREASED REPAIR EFFORT AND COST.

NEW 2x4 SHAPED BLOCKING

NEW STRUCTURAL SHEATHING

NEW 8d NAILS @ 4" O.C. ALL SIDES OF SHEATHING

MORE THAN 18"

NEW 2x4 SHAPED VERTICAL EACH SIDE EACH TRUSS

ANCHOR BLOCKING OPTION #3
MORE THAN 18"

PROVIDE VENT HOLES

NEW STRAP TIE EXISTING FRAMING

(4) NEW 10d NAILS AT EACH VERTICAL EACH SIDE OF TRUSS

1" CLEAR

NEW FRAMING ANCHOR EACH SIDE EXISTING PLATE

SECTION A-A

EDGE BLOCKING OPTIONS AT TRussed ROOF

<table>
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<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: MODEL A &amp; B</th>
<th>Roof Diaphragm Strengthening</th>
<th>DETAIL: 40a</th>
</tr>
</thead>
</table>
WHEN RE-ROOFING, REMOVE OLD SHINGLES AND INSTALL ¾" OSB SHEATHING W/ 10d NAILS @ 6" O.C. AT ALL PANEL EDGES, AND 12" O.C. IN FIELD

EXISTING ROOF SPACED 1x SHEATHING

EXISTING FRAMING

2x4 SOLID FLAT BLOCKING BETWEEN JOISTS AT ALL SHEATHING EDGES

WHEN POSSIBLE, RECOMMEND REMOVAL OF EXISTING 1x SPACED SHEATHING WHEN RE-ROOFING

41 ROOF DIAPHRAGM STRENGTHENING

Seismic Improvement Structural Detail | HOME TYPE: ALL MODELS | Roof Diaphragm Strengthening | DETAIL: 41
NEW 7/6" OSB SHEATHING OVERLAY

20 GAUGE x CONT. BENT PLATE W/ #12 x 2½" SCREWS @ 6" O.C. EACH SIDE

NEW 2x4 FLAT BLOCKING EACH SIDE

EXISTING ROOF SHEATHING

EXISTING FRAMING

NOTE:
SHEAR TRANSFER UPGRADE AT RIDGE AND HIP RIDGE SIMILAR.

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<th>Seismic Improvement</th>
<th>HOME TYPE: ALL MODELS</th>
<th>Roof Diaphragm Strengthening</th>
<th>DETAIL</th>
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<tr>
<td>Structural Detail</td>
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<td>42</td>
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</table>
Floor anchorage and strengthening: Details 50–57

SEE DETAIL 5 & 7
FOR EXISTING CONDITION

10d NAILS @ 4” O.C.

TENSION TIE WITH
3/4” DIA THRU BOLT
@ 48” O.C.

EXISTING FLOOR
STRUCTURE, SEE 57
FLOOR

NAILS AS REQUIRED
BY THE MANUFACTURER

EXISTING CEILING,
REMOVE & REPLACE
AS REQUIRED

NEW 2x SOLID PRESSURE
TREATED BLOCKING
BETWEEN JOISTS

1 1/2” CLEAR MIN.

3/4” DIA THREADED
ROD IN EPOXY FILLED
SCREEN TUBE

LOWER STRENGTH
EPOXY ANCHOR OPTION

FLOOR TO URM WALL ANCHORAGE
WITH JOISTS PERPENDICULAR TO WALL
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

**Flat Framing Anchor**
- Pressure treated 2x8xCont. w/ 3/4” dia threaded rod in epoxy
- Anchoring system @ 48” O.C. Max

**Existing Masonry Wall**
- 3/4”x6” min. galvanized plate washer or steel band – embed into bead of sealant (where plate washer is objectionable, see)

**Existing Concrete Foundation Wall**

**Floor to URM Wall & Foundation Wall**
- Anchorage w/joists perpendicular to wall

**Table:**

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE MODEL A,B,C,D,&amp;F</th>
<th>Floor to URM Wall Anchorage</th>
<th>DETAIL</th>
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<td>51</td>
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</table>
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**Seismic Improvement Structural Detail**

**MODEL E**

**Floor to URM Wall Anchorage**

**DETAIL: 52**

---

**FOUNDATION ANCHOR @ 48" O.C.**

W/ (2) 1/2" DIA THREADED ROD IN EPOXY ANCHORING SYSTEM AND NAILED AS REQUIRED BY MANUFACTURER

**EXISTING MASONRY WALL**

10d NAILS @ 4" O.C.

**NEW 2x SOLID PRESSURE TREATED BLOCKING BETWEEN JOISTS**

**EXISTING FLOOR STRUCTURE, SEE**

**2½" MIN TO BOLT C**

L3x3x⅜ @ 48" O.C.

W/ (2) 5/8" DIA THRU BOLTS INTO JOIST AND (2) 3/4" DIA THREADED RODS IN EPOXY ANCHORING SYSTEM AT EACH ANGLE @ 8" O.C. MIN

**EXISTING CONCRETE FOUNDATION WALL**

**FLOOR TO URM WALL & FOUNDATION WALL ANCHORAGE W/JOISTS PERPENDICULAR TO WALL**
$_{\frac{3}{4}}" x 6"$ MIN. GALVANIZED
PLATE WASHER OR
STEEL BAND – EMBED
INTO BEAD OF SEALANT
(WHERE PLATE WASHER
IS OBJECTIONABLE,
SEE )

EXISTING FLOOR BEAM AND
FLOOR STRUCTURE ABOVE
(2) 3/4" DIA THRU BOLTS

EXISTING FOUNDATION
WALL

L6x6x3/4 W/(2) 3/4"
DIA THREADED RODS
IN EPOXY ANCHORING
SYSTEM ON EACH SIDE

SECTION A–A

SEE DETAIL FOR
EXISTING
CONDITION

50 FLOOR

56 FLOOR

53 FLOOR

FLOOR BEAM TO
FOUNDATION WALL ANCHORAGE

Seismic Improvement
Structural Detail

HOME TYPE:
MODEL A,B,C,&D

Floor to URM
Wall Anchorage

DETAIL:
53
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

**Seismic Improvement Structural Detail**

**Home Type:** MODEL A, B, C, & D

**Floor to URM Wall Anchorage**

**Floor: 54**

**Diagram Description:**

- **Between Joists:**
  - Flat Framing Anchor
  - Pressure treated 2x8xCont. W/ 3/4" Dia threaded rod in epoxy anchoring system @ 48" O.C. Max

- **Existing Masonry Wall:**
  - 3/4"x6" Min. Galvanized plate washer or steel band - embed into bead of sealant (where plate washer is objectionable, see 50 Floor)

- **Existing Foundation Wall:**
  - 2½" Min to bolt Ø
  - New 2x solid pressure treated blocking
  - L3x3x⅜ @ 48" O.C. W/ (2) 5/8" Dia thru bolts into joist and (2) 3/4" Dia threaded rods in epoxy anchoring system at 8" O.C. Min

**Floor to URM Wall & Foundation Wall Anchorage W/Joists Parallel to Wall**
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

**Diagram:**

- **Existing Masonry Wall**
- **Existing Framing**
- **Hold Down Anchor**
  - W/ 3/4" Dia Thru Bolt
  - @ 48" O.C. Max
- **Strap Tie Across Joist Top and Bottom**
- **Existing Ceiling, Remove & Replace As Required**
- **New 2x Solid Pressure Treated Blocking**
  - @ 48" O.C. W/Framing Anchors Each End, Extend Blocking (2) Joist Spaces.

**Table:**

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<tr>
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<th>Home Type:</th>
<th>Wall Anchorage</th>
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<td></td>
<td>MODEL C &amp; D</td>
<td>Floor to URM</td>
</tr>
<tr>
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<td>Anchorage</td>
</tr>
<tr>
<td></td>
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<td>DETAIL: 56</td>
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</table>
EXISTING FRAMING
EXISTING FLOOR SHEATHING
NEW 3/16" OSB SHEATHING OR OSB OVERLAY WITH 10d NAILS @ 6" O.C.
ALL PANEL EDGES, 10d NAILS @ 12" O.C. TO EXISTING FRAMING
IN FIELD. BE SURE TO HEAVILY GLUE NEW SHEATHING DOWN TO OLD
TO HELP MINIMIZE SQUEAKS

FLOOR DIAPHRAGM STRENGTHENING

| Seismic Improvement Structural Detail | HOME TYPE: ALL MODELS | Floor Diaphragm Strengthening | DETAIL: 57 |
Wall strengthening: Details 70–82

EXISTING MASONRY WALL

REINFORCE WALL WITH HELICAL MECHANICAL ANCHORS @ 16” O.C. EACH WAY

1 1/2” CLEAR MIN.

NOTE: HELICAL TIES MAY BE INSTALLED IN MULTI-WYTHE BRICK WALLS IF BENEFICIAL

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<th>Seismic Improvement Structural Detail</th>
<th>Home Type: Varies</th>
<th>URM Wall Strengthening</th>
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<td>WALL 70</td>
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EXISTING MASONRY WALL

REINFORCE WALL WITH HELICAL MECHANICAL ANCHORS @ 16" O.C. EACH WAY

1½" CLEAR MIN.

NOTE:
HELICAL TIES MAY BE INSTALLED IN MULTI-WYTHE BRICK WALLS IF BENEFICIAL

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>Home Type</th>
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<tr>
<td>VARIES</td>
<td></td>
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<td>71</td>
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</table>
EXISTING MASONRY WALL

REINFORCE WALL WITH HELICAL MECHANICAL ANCHORS @ 16" O.C. EACH WAY

2" MIN. SHOTCRETE OVERLAY (f'c=4000 PSI)
REINFORCE W/ 6x6-W2.9x2.9 WELDED WIRE FABRIC – ALLOW HELICAL MECHANICAL ANCHORS TO PROJECT INTO GROUT 1", AND TIE WWF TO HELICAL ANCHORS. (APPLY OVERLAY TO INTERIOR OR EXTERIOR SURFACE OF WALL)

1/2" CLEAR MIN.

URM WALL STRENGTHENING

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<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE:</th>
<th>URM Wall Strengthening</th>
<th>DETAIL</th>
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EXISTING MASONRY WALL

#3 REINFORCING STEEL
W/ 3" HOOK IN EPOXY FILLED
SCREEN TUBE @ 24" O.C.
HORIZONTAL & VERTICAL

2" MIN. SHOTCRETE OVERLAY
(f’c=4000 PSI)
REINFORCE W/ 6x6-W2.9x2.9
WELDED WIRE FABRIC – HOOK
INTO ENDS OF THREADED RODS.
(APPLY OVERLAY TO INTERIOR OR
EXTERIOR SURFACE OF WALL)

1½” CLEAR MIN.

22.5°

URM WALL STRENGTHENING

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<th>Seismic Improvement</th>
<th>HOME TYPE:</th>
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<th>DETAIL</th>
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<tr>
<td>Structural Detail</td>
<td>VARIES</td>
<td></td>
<td>73</td>
</tr>
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</table>
(2) 3/8" x 16 GA. METAL C STUDS

#12 SCREWS @ 6" O.C. EA. SIDE INSULATION

GYPSUM SHEATHING OR 7/16" OSB SHEATHING

EXISTING MASONRY WALL

3/8" DIA THREADED ROD IN EPOXY FILLED SCREEN TUBE @ 24" O.C. HORIZONTAL & VERTICAL

GYPSUM SHEATHING OR 7/16" OSB

1/2" CLEAR MIN.

PLAN VIEW A-A
EXISTING HOLLOW BLOCK WALL

2" SHOTCRETE OVERLAY (f’c=4200 PSI)
REINFORCE W/ 6x6-W2.9x2.9
WELDED WIRE FABRIC
(APPLY OVERLAY TO INTERIOR OR EXTERIOR SURFACE OF WALL)

BREAK OUT 8"x8" FACE SHELLS
AT 24" O.C. HORIZONTAL AND VERTICAL. ALLOW GROUT TO FLOW INTO CELLS TO PROVIDE A MECHANICAL INTERLOCK, AND PROVIDE BENT "U" OR TUBE OF WELDED WIRE FABRIC AT EACH CELL.

URM WALL STRENGTHENING

| Seismic Improvement Structural Detail | HOME TYPE: MODEL F | URM Wall Strengthening | DETAIL: 75 |
EXISTING HOLLOW BLOCK WALL

SAW-CUT FACE SHELL FULL HEIGHT. INSERT #5 BAR AND GROUT SOLID

PLAN VIEW

URM WALL STRENGTHENING

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<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE:</th>
<th>URM Wall Strengthening</th>
<th>DETAIL:</th>
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<tbody>
<tr>
<td>MODEL F</td>
<td></td>
<td></td>
<td>76</td>
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</tbody>
</table>
NOTE:
WALL SHEATHING (USUALLY PLASTER OR GYPSUM BOARD) NOT SHOWN FOR CLARITY. REMOVE AND REPLACE AS REQUIRED FOR CONSTRUCTION.

**Interior Bearing Wall to Slab Anchorage**

| Seismic Improvement Structural Detail | HOME TYPE: VARIES | Interior Bearing Strengthening | DETAIL: 77 |
(1) 3/8" DIA. THRU BOLT

EXISTING WOOD POST

L6x4x5/6x WIDTH OF POST W/ 1/2" DIA EPOXY ANCHOR EACH SIDE, OR SEISMICALLY RATED MECHANICAL ANCHORS, (OR EQUAL)

EXISTING CONCRETE SLAB ON GRADE
EXISTING SUBGRADE

INTERIOR POST TO SLAB ANCHORAGE

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE:</th>
<th>Interior Bearing Strengthening</th>
<th>DETAIL:</th>
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</thead>
<tbody>
<tr>
<td>VARIIES</td>
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<td>78</td>
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</tbody>
</table>
NEW 2x SOLID BLOCKING BETWEEN JOISTS - TOE NAIL TO EACH END W/ (2) 10d NAILS

EXISTING WOOD STUD BEARING WALL W/ 2x'S EQUALLY SPACED

TOE NAIL BLOCKING OR INSTALL FRAMING ANCHORS FROM BLOCKING TO PLATE (TYPICAL)

EXISTING SOLE PLATE

EXISTING FLOOR SHEATHING

EXISTING (2) 2x TOP PLATE

EXISTING 2x WOOD JOIST EACH SIDE

HOLD DOWN ANCHOR W/ WASHERS TOP AND BOTTOM W/ THREADED ROD THRU FLOOR AT ENDS OF WALLS AND OPENINGS (USE AT FIRST AND UPPER STORY SITUATIONS AS NEEDED OR WHERE ENGINEERING CALCULATIONS DICTATE).

NOTE:
WALL SHEATHING (USUALLY PLASTER OR GYPSUM BOARD) NOT SHOWN FOR CLARITY. REMOVE AND REPLACE AS REQUIRED FOR CONSTRUCTION.

WOOD JOIST TO INTERIOR BEARING WALL AT FLOOR JOISTS

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: VARIES</th>
<th>Interior Bearing Strengthening</th>
<th>DETAIL: 79</th>
</tr>
</thead>
</table>
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

- **EXISTING WOOD POST**
- **NEW 2x SOLID BLOCKING BETWEEN JOISTS – TOENAIL TO EACH END W/ (2) 8d NAILS**
- **EXISTING FLOOR JOIST EACH SIDE**
- **EXISTING FLOOR SHEATHING**
- **FRAMING ANCHORS FROM BLOCK TO BEAM (TYPICAL)**

**7 BOLT DIAMETERS MIN. TO BOLT CENTER (TOP AND BOTTOM OF POST)**

**WOOD POST TO INTERIOR BEAM LINE AT FLOOR JOISTS**

| Seismic Improvement Structural Detail | HOME TYPE: VARIES | Interior Bearing Strengthening | DETAIL: 80 |
The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings

NEW 2x SOLID BLOCKING BETWEEN JOISTS IF NO BLOCKING EXISTS — TOENAIL TO EACH END W/ (2) 8d NAILS

NEW FRAMING ANCHORS FROM BLOCK TO BEAM (TYPICAL)

EXISTING (2) 2x TOP PLATE

EXISTING (2) 2x TOP PLATE

EXISTING 2x WOOD JOIST EACH SIDE

EXISTING WOOD STUD BEARING WALL W/ 2x’S EQUALLY SPACED

NOTE:
WALL SHEATHING (USUALLY PLASTER OR GYPSUM BOARD) NOT SHOWN FOR CLARITY. REMOVE AND REPLACE AS REQUIRED FOR CONSTRUCTION.

WOOD JOIST TO INTERIOR BEARING WALL AT CEILING JOISTS

Seismic Improvement Structural Detail

HOME TYPE: VARIES

Interior Bearing Strengthening

DETAIL: 81
NEW 2x SOLID BLOCKING BETWEEN JOISTS IF NO BLOCKING EXISTS - TOENAIL TO EACH END W/ (2) 8d NAILS
FRAMING ANCHORS FROM BLOCK TO BEAM (TYPICAL)
EXISTING 2x WOOD JOIST EACH SIDE
EXISTING WOOD BEAM
NEW METAL POST CAP
EXISTING WOOD POST

82 WALL
WOOD POST TO INTERIOR BEAM LINE AT CEILING JOISTS

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: VARIES</th>
<th>Interior Bearing Strengthening</th>
<th>DETAIL: 82</th>
</tr>
</thead>
</table>
Foundation anchorage and strengthening: Detail 90

**ELASTOMERIC SEALANT OVER BACKER ROD**

**EXISTING FOUNDATION WALL**

6" CONCRETE OVERLAY ($f'_c=3000$ PSI)
REINFORCE W/ #4 @ 12" O.C.
VERTICAL AND HORIZONTAL
(OPTION: OVERLAY MAY BE LOCATED ON THE INTERIOR OF FOUNDATION WALL)

THOROUGHLY CLEAN SURFACE OF EXISTING FOUNDATION WALL PRIOR TO PLACING NEW CONCRETE (SANDBLAST, ETC.)

**DOWEL INTO EXISTING WALL**
W/ 5/8" DIA x 10" EPOXY ANCHORS @ 24" O.C. EACH WAY

**FOUNDATION WALL STRENGTHENING**

<table>
<thead>
<tr>
<th>Seismic Improvement Structural Detail</th>
<th>HOME TYPE: VARIES</th>
<th>Foundation Wall Strengthening</th>
<th>DETAIL: 90</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
CHAPTER 7

Non-Structural Seismic Hazards: Anchorage and Bracing

Chapter 7 includes details for upgrading non-structural seismic hazards that include, but is not limited to, furnishings, appliances, computers, tall cabinets, machines, mechanical and electrical equipment (water heaters, lights, etc.), and other non-structural elements or building equipment contents which are not directly related to the structural frame, wall, floor(s), and roof of the dwelling structure.

The dislodgment of non-structural elements in a dwelling is a potential life safety hazard during an earthquake. Currently adopted building codes have made a reasonable attempt to address the bracing and anchorage of many non-structural elements, however this is still often overlooked in residential construction. When a dwelling shakes, non-structural elements and building contents, like heavy equipment, furniture, computers, artwork, and other articles, may slide around violently causing extensive damage both to the object and to the surrounding area. It is not uncommon for a structure to have survived severe ground shaking without serious structural damage while non-structural elements and dwelling contents are almost a total loss. When this involves expensive furnishings, equipment, antiques, artwork, and other personal items, the homeowner can sustain an enormous financial and emotional loss. The displacement of dwelling contents can often be inexpensively reduced. The mitigation details at the end of this chapter are intended to reduce the potential for large dwelling content losses resulting from an earthquake.
Individual Non-Structural Seismic Improvement Details

Details to anchor non-structural items

(Details 100–115)

Water heater bracing: Details 100–101

Floor-mounted equipment: Detail 102

Light-duty shelving: Detail 103

Bookshelves against wall: Detail 104

Anchoring freestanding bookcase: Detail 105

Computers and accessories: Detail 106

Wall-mounted televisions: Detail 107

Desktop/counter equipment restraint: Detail 108

Restraining brackets/straps: Detail 109

Wall-mounted file cabinets: Detail 110

Base-anchored file cabinets: Detail 111

Wall/base-anchored lateral file cabinets: Detail 112

Shelf-mounted items: Detail 113

Fragile artwork restraints: Detail 114

Pendant light anchoring: Detail 115

Note: Engineering required for all permanent floor-supported cabinets or shelving over 6 feet tall. Details shown are adequate for typical shelving 6 feet or less in height.
Water heater bracing: Details 100–101
Figure 6.4.2.4-7
Water heater - corner installation

- Wrap one full circle around tank or water heater
- Metal straps (Minimum 3/4" X 24 gauge, may be perforated)
- Flexible gas connection
- Flexible water connections
- First stud not behind heater
- Encircle tank one full wrap from front and back with metal strap (2 pieces total)

Plan View

- Water heater
- Concrete or masonry wall
- 1/4" minimum diameter x 3" lag screw w/flat washer
- 1/4" minimum diameter anchors w/2" minimum embedment

Seismic Improvement Non-Structural Detail

- HOME TYPE: VARIES
- Water Heater Bracing
- DETAIL: 101


Last Modified: December 2012
Floor-mounted equipment: Detail 102

Flexible connections between equipment and piping will reduce the potential for pipe breaks and leaks.

Dimensions of angles and location of anchors and/or bolts provided by design.

Note: snubbers may be used for seismic restraint of equipment that is relatively short and squat. Tall, slender equipment requires positive anchorage to prevent overturning (See Figures 6.4.1.1-6, 7).

Light-duty shelving: Detail 103

Bracing by manufacturer.

Notes: Purchase shelving units designed for seismic resistance. Engineering required for all permanent floor-supported cabinets or shelving over 6 feet tall.

Verify mechanical construction (bolt or screw) between leg and base (if adjustable).

Anchor base plate to concrete.
Use 2-3/8" expansion anchors @ 3" min. OC through base plate.
For smaller units with H/D ≤ 2, 1 anchor is acceptable.
Bookshelves against wall: Detail 104

Where rear wall of bookcase is wood or metal with mechanical connection to bookcase framing, unit may be fastened directly to wall studs with 1/4” sheet metal screw and washer, 2 minimum, top and bottom.

2 X 4 min. wood stud or 20 ga. min. metal stud @ 24” oc max. Verify that studs run full height to floor above or are adequately braced to structural framing.

$L_{2-1/2} \times 2-1/2 \times 1/8$ X 1”-6” min. with 1-1/4” sheet metal screw, or 1/4” toggle bolt to other metal studs, 1/4” wood screw with 2” penetration in wood stud. Fasten to a minimum of two studs.

Center of studs

For connection to concrete or masonry walls, use 3/8” diameter expansion anchors in lieu of sheet metal screws.

$L_{2-1/2} \times 2-1/2 \times 1/8$ X 0”-7” (min.) each side with 3-#10 sheet metal screws to cabinet and 2-3/6” diameter expansion anchors to floor slab.

**Note:** Engineering required for all permanent floor-supported cabinets or shelving over 6 feet tall. Details shown are adequate for typical wall-supported shelving up tp 6 feet tall.

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<table>
<thead>
<tr>
<th>Seismic Improvement Non-Structural Detail</th>
<th>TYPE</th>
<th>BOOKSHELVES AGAINST WALL</th>
<th>DETAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VARIIES</td>
<td></td>
<td></td>
<td>104</td>
</tr>
</tbody>
</table>
Anchoring freestanding bookcase: Detail 105

Gang multiple units with steel plates, 1" X 4" X 12 ga. min. with 2-#12 sheet metal screws or 1/4" Ø bolts each end, min.

Alternate: Bolt together through back with 2 - 1/4" Ø bolts top and bottom between, min. Add solid blocking if backs of units are not in contact.

L2-1/2 X 2-1/2 X 1/8 X 1'-0" min. with 4 #10 sheet metal screws to bookcase. and 2 - 3/8" Ø expansion anchors to slab (each side).

Note: Engineering required for all permanent floor-supported cabinets or shelving over 6 feet tall. Details shown are adequate for typical shelving 6 feet or less in height.
Computers and accessories: Detail 106

**MITIGATION DETAILS**

Figure 6.5.3.3-3 Desktop computers and accessories (NE).

**CPU Tower**
4-Point fastening – use for all CPUs

**Safety Fastener**

- Safety fasteners in each side of CPU
- 4" Strap
- Locking device

**Note:** Many proprietary fasteners are available to restrain countertop items. Check the internet for options.

**CPU**

**Monitors**

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<table>
<thead>
<tr>
<th>Seismic Improvement</th>
<th>HOME TYPE:</th>
<th>Computers and Accessories</th>
<th>DETAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Structural Detail</td>
<td>VARIES</td>
<td></td>
<td>106</td>
</tr>
</tbody>
</table>
Wall-mounted televisions: Detail 107

**Figure 6.5.3.4-4 Wall-mounted bracket for television or monitor weighing less than 50 lb (NE).**

- **Note:** Select bracket rated for weight of television/monitor. For weights > 50 lb., provided engineered detail.

<table>
<thead>
<tr>
<th>Seismic Improvement Non-Structural Detail</th>
<th>HOME TYPE:</th>
<th>Wall-mounted Television</th>
<th>DETAIL:</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>VARYES</td>
<td></td>
<td>107</td>
</tr>
</tbody>
</table>
Desktop/counter equipment restraint: Detail 108

Seismic Improvement Non-Structural Detail: VARIES

Desktop/Counter Equipment Restraint

DETAIL: 108
Restraining brackets/straps: Detail 109

Figure 6.5.6.2-4  Desktop/countertop equipment restraining brackets (NE).

<table>
<thead>
<tr>
<th>Seismic Improvement Non-Structural Detail</th>
<th>HOME TYPE</th>
<th>Restrainting Brackets/Straps</th>
<th>DETAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VARIES</td>
<td></td>
<td></td>
<td>109</td>
</tr>
</tbody>
</table>
Wall-mounted file cabinets: Detail 110

Steel angle at both ends (or both sides of single unit) L2-1/2 X 2-1/2 X 1/8 (min.) with 3 - #10 sheet metal screws to cabinet and 2 - 3/8" diameter expansion anchors to concrete floor slab.

Angle connection to wall may be omitted where H/D and H/L < 3 in accordance with engineered design.

1/4" Ø round head machine bolt with hex nut and washer interconnecting cabinets. Verify no internal obstruction before installation.
Base-anchored file cabinets: Detail 111

Base Anchorage Alternate: In lieu of connecting file cabinets to the floor via added angles, some models permit direct anchorage through the base. Use 4 anchors in each cabinet for free-standing units.

Multiple Units: Top Down View
Bolt adjacent units top and bottom, typical

Angle to floor

1/4" Ø round head machine bolt with hex nut and washer interconnecting cabinets (two at the front and two at the rear) verify no internal obstruction before installation.

Note: Engineering required for permanent floor-mounted cabinets over 6 feet tall.
Wall/base-anchored lateral file cabinets: Detail 112

Centerline of wall stud

Typically 16" or 24" spacing

Steel angle connected to minimum of two wall studs. $L2-1/2 \times 2-1/2 \times 1/8$ (min.) with 3 - #10 sheet metal screws to cabinet

1/4" sheet metal screw and washer to metal stud 20 ga. or thicker; 1/4" toggle bolt and washer to other metal studs; 1/4" wood screws and washer with 2" penetration each wood stud.

Alternate: Direct connection to wall studs through back of cabinet
Use "mounting strip" where desired. Fasten continuous 2 X 6 or similar to each stud with 2 screws each; fasten cabinet to mounting strip as indicated.

4 Drawer Lateral File

5" min.

2 Drawer Lateral File

5" min.

Base Anchorage Alternate: In lieu of connecting cabinet to floor with angles, some models permit direct anchorage to the floor through the base.

Steel angle connected at both sides $L2-1/2 \times 2-1/2 \times 1/8$ (min.) with 3 - #10 sheet metal screws to cabinet and 2 - 3/8" diameter expansion anchors to floor
Shelf-mounted items: Detail 113

- Anchor storage shelving to wall studs
- The height of the lip depends on the height of the stored contents: taller items require taller lips
- Screw lip to shelf
- Channel or strut screwed to wall studs or sturdy casework
- Elastic strap restraint (bungee cord with hook or strap with tightening mechanism for example)
- Metal wire, elastic strap or solid lip anchored to cabinet
- Keep top free of heavy items especially if located near person sitting at desk or lying in bed.
- Where shelves are located inside cabinets with doors, latching mechanism on doors may be used in lieu of individual shelf restraints
Fragile artwork restraints: Detail 114

Use museum wax to restrain small lightweight objects. (Remove with care - wax may leave small stain on base of object). Alternative: use patches of hook and loop material. [Caution - glue may affect finish on base of object].

Place object in close-fitting glass or plexiglass display case. Pedestal must be anchored.

Anchor display case to floor or wall

Wire attached to frame with closed hook or closed wire loop

Wood, plastic, or metal lip edge screwed to shelving unit

Hanging framed item

Note: Specialty hardware such as base isolated display platforms are available for especially fragile or valuable items. Seek professional guidance for expensive or irreplaceable items.
Pendant light anchoring: Detail 115

If swinging of fixture can cause contact with other items, provide diagonal wires or bracing to restrain movement.
APPENDIX A

Supplemental Information Sources

References


Applied Technology Council, 1999. Built to resist earthquakes, the path to quality seismic design and construction.


Earthquake Engineering Research Institute and International Association for Earthquake Engineering, 2011. Improving the seismic performance of stone masonry buildings.


Utah Division of State History, 1993. Bracing for the big one.


Other Information


Structural Engineers Association of Utah (SEAU): http://seau.org/

University of Utah Seismograph Stations (UUSS): http://quake.utah.edu

Utah Division of Emergency Management (UDEM): http://dem.utah.gov/

Utah Division of Occupational and Professional Licensing (DOPL): http://dopl.utah.gov


**APPENDIX B**

**Glossary**

**bearing walls**: Walls that support any vertical load in a dwelling as well as its own weight.

**brick veneer**: When brick or masonry is used as a façade, or covering, rather than as a structural element. Many dwellings may appear to have masonry bearing walls when in truth they may consist of wood-frame construction having masonry veneer on the exterior.

**cantilever**: A projecting beam or member that sticks out from a wall or other structure to support something above it, such as a balcony.

**column (or post)**: A vertical structural element that often supports horizontal girders or beams.

**corbel**: An architectural member that projects from within a wall and supports a weight.

**ductility**: The ability of solid material to deform under tensile stress.

**dwelling**: A house, apartment, or other place of residence.

**footing**: Horizontal portion of the foundation that transmits load to the soils.

**gable end walls**: Triangle section of an exterior wall that occurs under the roofline and above the eaves.

**in-plane failure**: When lateral forces (i.e., earthquake and wind) are introduced parallel to the wall causing the wall to be displaced horizontally within the plane of the wall.

**joist**: A beam placed repetitively to support a floor or roof.

**lateral force resisting elements**: Those portions of a building that provide the basic lateral strength and stiffness, and without would cause the building to be unstable (i.e., shear wall, moment frames, braced frames, etc.).

**lintel**: A structural member placed horizontally over an opening (such as a door or window) to support the load above.

**mortar**: A mixture of cement, sand, water, and other ingredients used to bond together bricks or concrete blocks.

**non-structural seismic hazards**: Items such as furnishings, appliances, computers, tall cabinets, machinery, electrical and mechanical equipment, etc.

**out-of-plane failure**: When lateral forces (i.e., earthquake and wind) are introduced perpendicular to the wall, and the wall either falls away from the floor(s) and/or roof or buckles between the floor(s) and roof.

**parapets**: Portions of the exterior walls that project above the roof line.

**pier**: The solid part of a wall between two openings (such as windows) at the same level.

**rafter**: Repetitive horizontal or sloping structural elements, usually of wood, that supports the roof sheathing.

**seismic design category**: Classification assigned to a structure based upon the use of the structure and the severity of the expected earthquake ground motion.

**sheathing**: The individual boards or plywood panels covering a wall, floor, or roof.

**stucco**: An exterior building finish made by a mixture of cement, sand, and water.

**unreinforced masonry (URM)**: Masonry construction built prior to 1970, before seismic requirements were added to the adopted building codes. This can include masonry construction having minimal steel reinforcement.

**veneer**: A masonry wall used for finish or surface treatment of a wall, not as a structural wall.

**wythe**: Multiple layers of bricks or other masonry components that comprise a bearing wall. Many URM dwellings have exterior bearing walls consisting of two to four wythes of brick.