Residential Seismic Retrofit Cost for Home Located in Tustin, California

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Seismically retrofitting a residential home not only protects the homeowner, but also helps them prepare for the future. Needless to say, many older homes are not up to the 2018 International Residential Code. As a result, many owners are uninformed about how much it will cost to retrofit their home and what changes will have to be made. The solution for this is determining a cost per square foot ratio that will help homeowners calculate an estimate for the retrofit of their home. Additionally, it is important to break this cost down into what specific changes need to be made. Those without construction backgrounds will then have a better understanding of where the costs are going. By forming this estimate and putting it into explicit terms, it will better educate homeowners and help them knowingly participate throughout the process. This is an important solution to a prevalent problem that can be integrated into the construction community to help bridge the gap between contractor and owner. This is not only beneficial for homeowners, but also contractors, as they can spend less time explaining the process, and simply perform the work with ease.

Key Words: Residential Construction, IRC, Seismic Retrofit, FEMA, California Earthquakes

Introduction

Building codes have existed in varying forms for centuries. However, seismic codes have not been around for very long. “At the time of the 1906 San Francisco earthquake, many California municipalities had building codes, but none considered seismic effects” (Evolution of Codes, n.d.). Once that earthquake occurred, it raised the opportunity for discussion about creating a seismic code and improving the design of buildings. Many professional organizations began to form all specifically for the creation of seismic codes. Once these organizations gained more traction, changes in building codes began to occur. For example, “revisions to the city of Santa Barbara’s building code in 1925 were the first explicit policy and legal consideration of the seismic safety of structures in California” (Evolution of Codes, n.d.). This was the first steppingstone to incorporate the possibility of earthquakes into building codes, which led us to the seismic codes we use currently today. With these new codes came the idea of ductility. This is the movement that a building undergoes during an earthquake. A structure that is rigid will not be ductile, and therefore, is more likely to collapse during

a seismic event. Ductility then paved the way for seismic structural engineering for all types of buildings and homes.

Structural engineering also introduced lateral loading. This is an important element to consider because lateral loading has different effects on a building. There are also a few ways that lateral loading can be exacerbated, which increases its weight on a building. The most common lateral forces are caused by wind and earthquakes. With this in mind, it is important to consider all types of loading on a building, as wind and earthquakes will merely shift the existing weight. These loadings can also include live loads and dead loads. Wind loads and seismic loads will also be discussed. Live loads are any temporary loads that act on a building. This can range from people, to furniture, to cars. Put simply, it consists of anything that can be moved throughout the building. Dead loads, however, are constant loads on a structure. This can be anything to actual structural elements like beams and the roof framing system, to fixed, permanent equipment that are an integral part of the structure, such as the Heating, Ventilation and Air Conditioning (HVAC) system. Combined, live loads and dead loads make up the weight of the building, whereas wind and seismic loads are additional forces that can disturb the existing weight. Wind and seismic loads will be dependent on the region the building is located in; however, they are no less important. This is especially the case in locations with high wind or frequent seismic activity. Wind can cause pressure and different forces around a building, which creates sporadic damage; whereas seismic events typically cause damage where the structure touches the ground. Overall, it is necessary to include all types of loading when designing and retrofitting new and old homes.

Objectives

The initial idea for this project came from the desire to learn about emergency management, given the current state affairs of the world. From this came the Federal Emergency Management Agency (FEMA), as they help reduce the increasing costs associated with disasters. Upon examining this agency, earthquake resistant design appeared, and with natural disasters on the rise, the typical homeowner may be unsure of what updates are necessary for their home. Many older residential homes, with the exception of new construction, renovations or remodels, are not seismically up to code. Currently, seismic codes are stressed for commercial buildings, as these have more daily occupants. However, those living in homes are just as important. With a lack of a well-known, comprehensive residential code and construction experience, many homeowners may not understand what updates need to be made, even when explained to them by an expert in residential construction or structural design. With a clear problem to solve, the aim of this project is to educate homeowners on the costs associated with seismic retrofits for their existing homes. In doing so, it is important to establish what changes need to be done in order to calculate the specific costs for updating. As stated earlier, many homeowners without construction backgrounds may find it difficult to grasp what changes are occurring, and as a consequence, will feel left out of the process. On the contrary, the homeowner needs to be included throughout all design, construction and finish processes. Without this, miscommunication can occur, as they may simply agree with whatever the general contractor says. To better bridge this gap, prevent further rework, streamline communication, and improve the relationships between general contractors, architects, engineers, and homeowners, it is necessary to discuss what distinct changes may need to occur by referencing the International Residential Code (IRC) and the Federal Emergency Management Agency (FEMA). By following these steps and keeping an open mind, all homeowners will be able to use this data and set of research tools to better educate themselves on residential seismic retrofit costs. With this in mind, throughout the project, it is important to answer these questions:

- Why is residential seismic retrofitting important?

- Will the costs of retrofitting outweigh the costs of simply buying a new home?
- What other tools can be utilized to determine seismic renovation costs and to better understand construction language?
- How will the cost change if another owner's home is in a different location?

Literature Review

First, it is important to establish a checklist of what needs to be retrofitted for the typical homeowner or homebuilder:

- Foundations
- Foundation Walls
- Floor Construction
- Walls
- Roof-Ceiling Systems
- Chimneys & Fireplaces
- Anchorage of Home Contents
- Permitting
- Additions and Alternations

This checklist will vary from home to home, dependent on the original materials, location and what alterations have already been completed. It is essential that the homeowner understand what changes are being made to their home, as the typical owner will have limited construction background. Whether it be a newly constructed home or a renovation, it is important that the relationship between the builder, design team and owner be open and participatory throughout the process. The following paragraphs will discuss how these changes can be implemented into an existing home.

Foundation

The first item on the checklist is the home's foundation. This is the most essential part of the home, as it protects against sliding and overturning actions that an earthquake permits. A general foundation requirement is, "regardless of seismic design category, all houses require a continuous foundation extending at least 12 inches below undisturbed soil along all exterior walls" (FEMA, 2006, p.49). It is important to check the original plans for this. Also required is a minimum specified concrete strength of 2,500 pounds per square inch (PSI). Furthermore, to properly upgrade the home, the addition of anchor bolts is necessary. These attach "the wall bottom plate or foundation sill plate to the concrete or masonry foundation" (FEMA, 2006, p.155). This protects the framing from sliding off the foundation and collapsing during a seismic event. Code states that ½-inch-diameter anchor bolts should be spaced at a maximum of 6 feet on center" (FEMA, 2006, p.99). Additionally, it is important to have rebar in the foundation and footings. "Typically, the bottom portion of a concrete footing must have one horizontal No. 4 reinforcing bar located 3 inches up from the bottom of the concrete (clear from the soil along the bottom of the footing)" (FEMA, 2006, p.53). Moreover, although concrete is strong in compression, it is very weak in tension. With this in mind, it is important to reinforce a home's foundation with reinforcing steel, also known as rebar. Rebar will also added to various other items on the checklist.

Foundation Walls

Next there are typically two types of foundations: concrete and masonry. For concrete foundation walls, they “shall be laterally supported at the top and bottom;” for plain masonry foundation walls, they “shall have a minimum nominal thickness … [of] 8 inches;” for rubble stone masonry foundation walls, they “shall have a minimum thickness of 16 inches” (IRC, 2019). These design requirements are integral to the structural integrity of a building during an earthquake.

Floor Construction

Floor systems transfer earthquake lateral loads to the foundation of a home. Consequentially, “floor joists (or trusses) are required to be connected to the top plate of supporting walls or to a foundation sill plate” (FEMA, 2006, p.75). Another form of flooring is concrete slab-on-grade. In the absence of expansive soils (dependent on the house location and soil type), the International Residential Cost (IRC) “does not require reinforcing of concrete slabs” (FEMA, 2006, p.81). Although not required, it is recommended that reinforcements be added to the concrete, as this will help with resistance to tension loads. Concrete has strong compression capabilities, but it performs poorly in tension.

Walls

Important to note, “in residential construction, the walls provide the primary lateral resistance to wind and earthquake loads” (FEMA, 2006, p.83). Four different bracing wall configurations are recognized by the IRC:

- IRC Section R602.10.3
- IRC Section R602.10.5
- IRC Section 602.10.6
- Wood structural panel sheathed walls with hold-down connections as required by the exceptions in IRC Section R703.7 when stone or masonry veneer is used

The homeowner or contractor can reference these sections specific to their home. Additionally, jack stud bracing is necessary. Jack studs “are partial-height wood light-frame walls that extend from the top of the foundation to the first framed floor” (FEMA, 2006, p.156). This component of a home is the easiest to seismically upgrade. Firstly, framing materials that show signs of moisture of decay should replaced or treated. Anchorage of “sheathing of the [jack studs] with wood structural panel sheathing applied to either the exterior or interior face of the crawl space walls” (FEMA, 2006, p.157). This helps further stabilize these walls, as they are very susceptible to damage during an earthquake.

Roof-Ceiling System

Next, the roof-ceiling system needs to be seismically upgraded. The roof transfers the earthquake lateral loads to the braced walls, which then transfer to the foundation. It is important to consider the dead load of the roof. This adds an extra weight that the walls and foundation need to carry. Without a proper calculation, the home will not be able to support itself during an earthquake. Depending on the roof shape, certain members may need to be inserted or replaced. It is important that the homeowner understand hip and valley beams and rafters, purlins, ridge boards, and blocking (see Figure 1 below). If all of the necessary members are not included in the current roof framing layout, or the original framing system was done incorrectly, it is imperative that it be reconstructed. Additionally, any framing members that are rotted, decaying, or show signs of moisture, should be replaced.

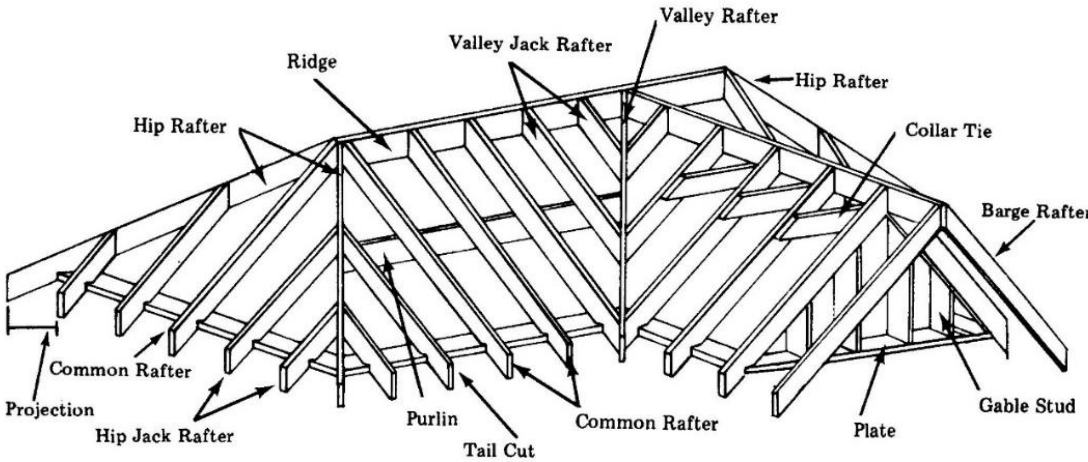

Figure 1 Roof Member Layout and Callout. (n.d.). http://www.nihb.com/wp-content/uploads/2016/12/Roof-Framing-Terminology-B.jpg

Chimneys & Fireplaces

Next, it is important to understand the IRC provisions for the seismic design and construction of chimneys and fireplaces for homes. Many homes contain masonry chimneys and fireplaces. Masonry chimneys are susceptible to earthquake damage, as they have a very rigid design. Rigid materials become brittle during seismic events and tend to collapse. Flexible materials are able to move with the movement of the earthquake and stay intact. Flexible materials are typically referred to as ductile. With bricks being a rigid material, there is potential for the collapse of the chimney and/or fireplace. To help improve the structural integrity of chimneys and fireplaces without having to reinstall new materials, reinforcements and anchorages are required. “Although these requirements cannot completely eliminate the possibility of damage to the fireplace and chimney in an earthquake, their use permits a chimney to better withstand earthquake loads and should lessen the falling hazard posed by a damaged chimney” (FEMA, 2006, p.132). This is an important item to retrofit, as it has the capabilities to damage not only the chimneys and fireplaces, but also the home overall.

In the International Residential Code, section R1003.3 refers to seismic reinforcing for chimneys. “For chimneys up to 40 inches wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed … within the cells of hollow unit masonry and grouted” (IRC, 2019). Furthermore, “an additional two No. 4 vertical bars are required for each additional … 40 inches of width” (FEMA, 2006, p.132). This is integral to keeping the chimney in place during an earthquake, as the masonry units are brittle. To anchor the chimney, “steel straps not less than 3/16-inch by 1-inch are required to extend a minimum of 12 inches into the chimney masonry, hook around outer reinforcing bars, and extend not less than 6 inches beyond the hook (FEMA, 2006, p.133). This is also located in section R1003.4 of the IRC. This further anchors the chimney in place, making it less susceptible to collapse. These same seismic reinforcing components are laid out for masonry fireplaces.

Anchorage of Home Contents

The most important item that needs to be anchored down are water heaters. “When not properly anchored, water heaters can fall over, resulting in a fire hazard and water damage” (FEMA, 2006,

p.141). They can either be wall braced or corner braced, both with a 30 to 75 gallon capacity. A simple solution for this would be to buy a kit at a hardware store. For securing other items, such as, drawer and cabinet latches, desktop computers and office equipment, gas cylinders, and miscellaneous furniture, it is recommended that it is done by the homeowner themselves. However, if there are any free standing walls or fences located outside, it is recommended that an engineering method is required. This is the case because “do-it-yourself methods” are likely to be ineffectual.

Permitting

Permit fees are typically the last thing on a homeowner’s mind and tend to get expensive based off of the renovation costs. It is important to add this cost in at the end of the estimate, so that it is based off of the total cost of the labor, materials and equipment. See the table below from the 2018 International Residential Code for the breakdown of permit fees:

Total Valuation	Fee
$1 to $500	$24
$501 to $2,000	$24 for the first $500; plus $3 for each additional $100 or fraction thereof, up to and including $2,000
$2,000 to $40,000	$69 for the first $2,000; plus $11 for each additional $1,000 or fraction thereof, up to and including $40,000
$40,001 to $100,000	$487 for the first $40,000; plus $9 for each additional $1,000 or fraction thereof, up to and including $100,000
$100,001 to $500,000	$1,027 for the first $100,000; plus $7 for each additional $1,000 or fraction thereof, up to and including $500,000
$500,001 to $1,000,000	$3,827 for the first $500,000; plus $5 for each additional $1,000 or fraction thereof, up to and including $1,000,000
$1,000,001 to $5,000,000	$6,327 for the first $1,000,000; plus $3 for each additional $1,000 or fraction thereof, up to and including $5,000,000
$5,000,001 and over	$18,327 for the first $5,000,000; plus $1 for each additional $1,000 or fraction thereof

Table 1 2018 International Residential Code, Appendix L, Permit Fees. (2019). https://codes.iccsafe.org/content/IRC2018P3/appendix-l-permit-fees

Additions and Alterations

When adding altering to an existing home, it is important to keep in mind that this will affect the load-resisting systems. “Generally, both the systems supporting gravity loads and those supporting lateral (wind and earthquake) loads are affected … but existing construction is allowed to remain unless it is made unsafe or will adversely affect the performance of the house” (FEMA, 2006, p.151). If additions or alterations are made to an existing home, and the homeowner would like to seismically update following that construction, it is necessary to recalculate the loading on the home. This will be an added cost on top of the estimate performed for this project.

Indirect Costs

To better help the homeowner understand the associated costs that come with construction, it is important to review surety bonds, overhead and profit markups, and insurance. The costs associated with a construction project include all of these extra costs whether it be a remodel, retrofit or new build. First are surety bonds. Surety bonds ensure a construction project’s bills get paid. Additionally,

the surety bond protects the owner in the case the contractor fails to complete a project or meet the specifications outlined in the contract. Next is overhead, which is all the indirect costs that cannot be directly related to the project. Profit is also allocated to each construction project. Lastly, construction insurance provides protection for mistakes, errors or unforeseen events that can lead to damages.

Methodology

The research for this project first began with seismic building code history, FEMA measures, and existing International Residential Codes. It was important to break down this existing knowledge into terms that a homeowner could use as a steppingstone to understand the complexities of residential seismic renovation. Following the research phase, an original set of house plans was obtained from Tustin, California. The plans, details and notes were analyzed to determine what changes should best be implemented given the existing conditions of the home. Discussions occurred with Eric Brinkman, a residential construction professor, to detail what updates would be necessary. From this, a quantity take off was prepared to create an estimate for the home. After the markups were complete and quantities of material were noted, the estimate was calculated using RS Means data. These costs were condensed into an approximate cost per square foot for the seismic upgrade. This gives the average homeowner a sense of what it would cost to retrofit their home, as they can use their current square footage. Please note that this research paper does not include a basement as part of this estimate, as they are uncommon in California.

Results

The total project cost for the home located in Tustin, California was $7,401.90. With a square footage of 2,682 SF, the average cost for the residential seismic retrofit was $2.76/SF. The estimate for this home first included reinforcing steel, also known as rebar. This was required for the existing foundation, as the foundation plans for the home showed very little existing rebar. Therefore, it was deemed necessary to add in more in the form of a grid for maximum tensile strength. When laying rebar for such a long span, it is important to include the lap length. A lap is when two pieces of rebar are overlapped to create a continuous line of rebar. This occurs when the pieces of rebar being used are not long enough for the entire span. These extra lengths were calculated into the total cost of rebar necessary for the foundation. Furthermore, rebar was added to the chimney, as the existing amount was too small, as the code had been updated since then. Lastly, rebar was also added to the existing footings on the home to ensure it is structurally sound. Also included on the estimate is an excavation cost. This is necessary because of the rebar rework. In order to add the rebar to the footings and foundation, excavation around the home is required. The next item included was jack stud sheathing. Jack studs are the most vulnerable during an earthquake, but also the easiest to fix. Sheathing was calculated for existing jack studs, with the exception of doors, windows and openings that had large existing headers. When larger headers are in place, jack studs are typically not used, and instead, a smaller header is placed on top. This requires no rework for those areas. Similarly, as excavation was included with rebar rework, wall sheathing is included with jack stud sheathing. In order to repair the existing jack studs, wall sheathing is removed. This sheathing then needs to be replaced, otherwise the home is left with holes in their walls, exposing their jack studs. Next, for labor, a foreman cost was added, as supervision for the retrofit is needed. The labor costs for the other work was already included. Lastly, a permit fee was calculated using the International Residential Code guidelines. No major equipment is required for this project. Once all of these material, labor, equipment, and permit costs were totaled, bonding, overhead, profit, and insurance were added as costs a general contractor would normally add on. The total cost was then converted to a cost per square foot ratio. The total

breakdown of these costs, as described above, is best shown on the estimate (see Appendix A). All of these costs were calculated using RS Means data and the International Residential Code.

In order to calculate the totality of the costs discussed, the house plans from Tustin, California were used. Markups were made on these plans for the rebar for the foundation, chimney and footings, jack stud and wall sheathing, and excavation. It was further determined through these plans what rework would not be needed. For example, no additional foundation was required, as it met the International Residential Code requirements for extending below undisturbed soil. For convenience of viewing, only the specific pages that were used and marked up are included (see Appendix B). These pages are the "Foundation Plan & Sections" (p.2 of 9), "Floor Plan & Schedules," (p.3 of 9), and the details of various types of interior and exterior footings and foundation slabs (p.7 of 9).

Lessons Learned

After conducting this project, it has become apparent that seismic retrofitting is not straightforward. A retrofit can depend on the home's location, the existing conditions, whether there has been any previous additions or alterations, and when the home was first constructed. Specifically, the location of a home may increase or decrease the associated costs. Some locations may have stricter seismic codes, bringing up the cost, while others may be more relaxed. Overall, the cost of retrofitting an existing older home will most likely be cheaper than buying a new one, although in extreme cases this may not be true. It is also important to consider inspections in the home's area. Inspections may require a wait period, which will push out the project schedule further, while also increasing the retrofit costs. Furthermore, it can be difficult to determine the exact structural components of a home. In some instances, older plans will not have as much detail that is present today or sheets may be missing. This can make seismic retrofitting, or any kind of addition or alternation, difficult for the contractor and homeowner. Unexpected difficulties may arise, making the changes more expensive than originally thought. All in all, residential seismic retrofitting is not as widespread as other codes. It would be in the best interest to make residential seismic codes a more universal topic. Although newer homes today are seismically sound, it is just as important to upgrade existing older homes.

Future Research

Future research can be conducted for this project through many different angles. Using the International Residential Code (IRC) of 2018 and Federal Emergency Management Agency (FEMA) was helpful, but determining the exact cost for a home will be dependent on the district's codes as well, although some will overlap. For example, this home can be reexamined using local seismic codes. Another example of future research that could be completed is comparing seismic retrofit costs for homes in different locations. This California retrofit may be more expensive, than a retrofit in Ohio. It would be interesting to discover what the differences are for various costs (for materials, labor, equipment, permitting, etc.), as well as specific codes. Additionally, another angle could be looking at the variances for commercial versus residential seismic codes, and whether one needs to be more incorporated into the other.

Lastly, different types of homes could be evaluated. High-end residential construction may require different techniques to seismically upgrade compared to homes on the lower-end. Structure Magazine discusses this very aspect and goes over one example of a home located near the San Andreas fault line, along with the homeowners' various demands. "To realize the owners' wishes, the firm decided to look beyond the ordinary code residential design and explore all the possibilities that advanced seismic structural design (ASSD) can offer" (Favretto, N., & Enckevort, J. V., 2019). The architects

examined many types of experimental codes before finally settling with ASSD. The article further talks about ASSD and its capabilities: “Advanced structural seismic design for high-end single-family residential construction largely increases the seismic performance of the structure with only a small overall construction cost increase” (Favretto, N., & Enckevort, J. V., 2019). This type of structural engineering could be the future for all homes – not necessarily high-end ones. The benefits of ASSD help homes perform better during seismic events and, therefore, increase the safety of the home and all the occupants living in it.

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Favretto, N., & Enckevort, J. V. (2019, July). Residential Seismic Design Using Viscous Dampers. Retrieved May 03, 2020, from https://www.structuremag.org/?p=14737

Figure 1 *Roof Member Layout and Callout*. (n.d.). Retrieved May 3, 2020, from http://www.nihb.com/wp-content/uploads/2016/12/Roof-Framing-Terminology-B.jpg

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Table 1 2018 International Residential Code Appendix L Permit Fees. (2019, September). Retrieved May 03, 2020, from https://codes.iccsafe.org/content/IRC2018P3/appendix-l-permit-fees

Appendix A

Please see the following page(s) for the total estimate and cost to seismically retrofit the home.

Tustin, CA Residential Seismic Upgrade Cost								
Estimate	Description	Unit	Quantity	Material $/Unit*	Labor $/Unit*	Material Cost	Labor Cost	Total
Material								
Rebar	#4 rebar foundation grid, lap length 41", spaced 36" o.c., 4 rodmen	TON	0.76	$ 1,185.75	$ 2,160.32	$ 902.97	$ 1,645.13	$ 2,548.10
	#4 rebar, chimney, 2 add'l, 4 rodmen	TON	0.01	$ 1,185.75	$ 2,160.32	$ 11.88	$ 21.65	$ 33.53
	#4 rebar, horizontal, footings, 4 rodmen	TON	0.14	$ 1,185.75	$ 2,160.32	$ 171.22	$ 311.95	$ 483.17
Jack Studs Sheathing	3/8" thick sheating, doors, 2 carpenters	SF	27.68	0.610	$ 0.66	$ 16.89	$ 18.27	$ 35.16
	3/8" thick sheating, openings, 2 carpenters	SF	13.20	0.610	$ 0.66	$ 8.05	$ 8.71	$ 16.76
	3/8" thick sheating, windows, 2 carpenters	SF	101.57	0.610	$ 0.66	$ 61.96	$ 67.03	$ 128.99
Wall Sheathing	1/2" gypsum board, 2 carpenters	SF	142.45	$ 0.61	$ 1.09	$ 86.90	$ 155.27	$ 242.17
Excavation		BCY	41.61	$ -	$ 30.50	$ -	$ 1,268.95	$ 1,268.95
Labor								
Foreman		EA	1	$ -	$ 1,241.00	$ -	$ 1,241.00	$ 1,241.00
Equipment								
N/A				$ -	$ -	$ -	$ -	$ -
Permit Fee**	$69 for the first $2,000; plus $11 for each add'l $1,000 or fraction thereof, up to and including $40,000							$ 112.98
Project Subtotal								$ 6,110.81
Bond (2%)								$ 122.22
Overhead (10%)								$ 611.08
Overhead Subtotal								$ 6,844.10
Profit (5%)								$ 342.21
Profit Subtotal								$ 7,186.31
Insurance (3%)								$ 215.59
Project Total								$ 7,401.90
Cost Per Square Foot								$ 2.76

*RS Means Data

**IRC Permit Fees Table

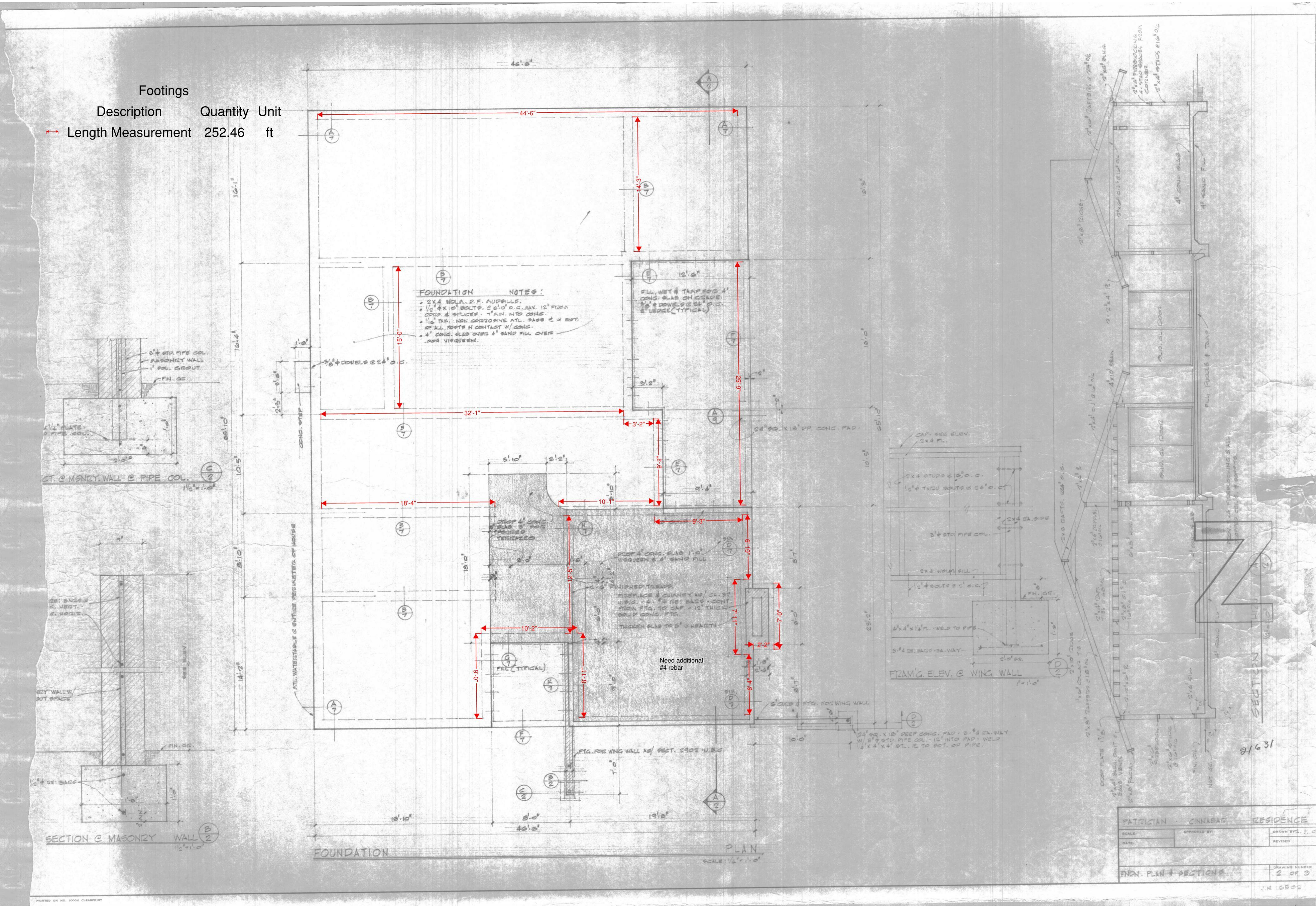
Appendix B

Please see the following page(s) for the utilized house plans, including:

- “Foundation Plan & Sections” (p.2 of 9)
- “Floor Plan & Schedules,” (p.3 of 9)
- The details of various types of interior and exterior footings & foundation slabs (p.7 of 9)

Footings

Description	Quantity	Unit
Length Measurement	252.46	ft



Doorways

Description	Quantity	Unit
Length Measurement	25.22	ft

Openings

Description	Quantity	Unit
Length Measurement	11.96	ft

Windows

Description	Quantity	Unit
Length Measurement	23.32	ft

Square Footage

HOUSE	2682 SQ.FT.
COVERED PORCHES	219 SQ.FT.
GARAGE	630 SQ.FT.

PATRICIAN - CINNABAR RESIDENCE

SCALE:

DATE:

APPROVED BY:

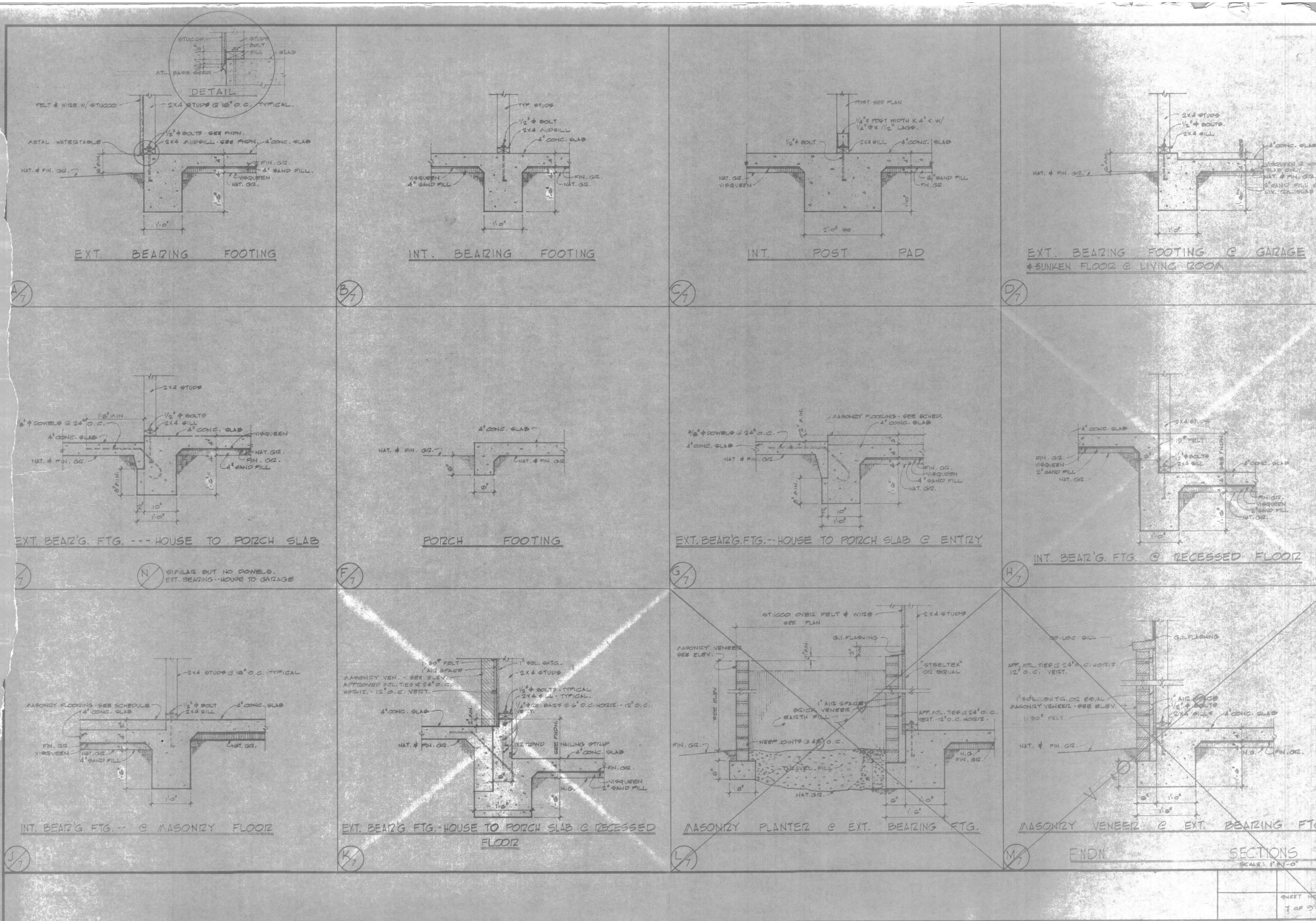
DRAWN BY

REVISED

FLOOR PLAN & SCHEDULES

DRAWING NUMBER 3 OF 9

J.N. 2608


DETAIL
STUCCO
ATL. BASE SCRR.
FELT & WIRE W/ STUCCO
2X4 STUDS @ 16" O.C. TYPICAL
METAL WATERTABLE
1/2" ϕ BOLTS - SEE FNDN.
2X4 MUDSILL - SEE FNDN.
4" CONC. SLAB
NAT. & FIN. GR.
FIN. GR.
4" SAND FILL
VISQUEEN
NAT. GR.
1'-0"
EXT. BEARING FOOTING
A/7
TYP. STUDS
1/2" ϕ BOLT
2X4 MUDSILL
4" CONC. SLAB
VISQUEEN
4" SAND FILL
FIN. GR.
NAT. GR.
1'-0"
INT. BEARING FOOTING
B/7
POST - SEE PLAN
1/2" ϕ BOLT
2X4 SILL
4" CONC. SLAB
NAT. GR.
VISQUEEN
4" SAND FILL
FIN. GR.
2'-0" SQ.
INT. POST PAD
C/7
2X4 STUDS
1/2" ϕ BOLTS
2X4 SILL
4" CONC. SLAB
NAT. & FIN. GR.
NAT. & FIN. GR.
1'-0"
EXT. BEARING FOOTING @ GARAGE
& SUNKEN FLOOR @ LIVING ROOM
D/7
2X4 STUDS
1/2" ϕ BOLTS
2X4 SILL
4" CONC. SLAB
VISQUEEN
NAT. GR.
FIN. GR.
4" SAND FILL
NAT. & FIN. GR.
1'-0"
EXT. BEAR'G. FTG. --- HOUSE TO PORCH SLAB
SIMILAR BUT NO DOWELS.
EXT. BEARING - HOUSE TO GARAGE
N/
4" CONC. SLAB
NAT. & FIN. GR.
NAT. & FIN. GR.
PORCH FOOTING
F/7
MASONRY FLOORING - SEE SCHED.
4" CONC. SLAB
4" CONC. SLAB
NAT. & FIN. GR.
FIN. GR.
VISQUEEN
4" SAND FILL
NAT. GR.
1'-0"
EXT. BEAR'G. FTG. -- HOUSE TO PORCH SLAB @ ENTRY
G/7
4" CONC. SLAB
FIN. GR.
VISQUEEN
2" SAND FILL
NAT. GR.
4" CONC. SLAB
1'-0"
INT. BEAR'G. FTG. @ RECESSED FLOOR
H/7
2X4 STUDS @ 16" O.C. TYPICAL
MASONRY FLOORING - SEE SCHEDULE
4" CONC. SLAB
1/2" ϕ BOLT
2X4 SILL
4" CONC. SLAB
FIN. GR.
VISQUEEN
NAT. GR.
4" SAND FILL
1'-0"
INT. BEAR'G. FTG. -- @ MASONRY FLOOR
J/7
1" SOL. SHTG.
1" AIR SPACE
2X4 STUDS
MASONRY VEN. - SEE ELEV.
1/2" ϕ BOLTS - TYPICAL
2X4 SILL - TYPICAL
4" CONC. SLAB
NAT. & FIN. GR.
4" CONC. SLAB
FIN. GR.
VISQUEEN
2" SAND FILL
N.G.
EXT. BEAR'G FTG. - HOUSE TO PORCH SLAB @ RECESSED FLOOR
K/7
STUCCO OVER FELT & WIRE
SEE PLAN
2X4 STUDS
G.I. FLASHING
MASONRY VENEER
SEE ELEV.
"STEELTEX" OR EQUAL
1" AIR SPACE
BRICK VENEER
EARTH FILL
FIN. GR.
WEEP JOINTS @ 48" O.C.
GRAVEL FILL
NAT. GR.
N.G.
FIN. GR.
MASONRY PLANTER @ EXT. BEARING FTG.
L/7
G.I. FLASHING
1" AIR SPACE
1/2" ϕ BOLTS
2X4 SILL
4" CONC. SLAB
NAT. & FIN. GR.
N.G.
FIN. GR.
MASONRY VENEER @ EXT. BEARING FTG.
M/7
FNDN. SECTIONS
SCALE: 1" = 1'-0"
SHEET NO.
7 OF 9