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Updating and Validation of Clark County Unreinforced Masonry Inventory Database

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Abstract

Western States Seismic Policy Council (WSSPC) Policy Recommendation 11-4 states: “Unreinforced masonry bearing-wall structures represent one of the greatest life safety threats and economic burdens to the public during a damaging earthquake. WSSPC recommends that each state, province or territory adopt a program to identify the extent of risk that unreinforced masonry structures represent in their communities and develop recommendations that will effectively address the reduction of this risk”.

This report details a project undertaken by Clark County Department of Building and Fire Prevention as an effort to identify the extent of risk associated with the presence of unreinforced masonry structures (URM’s) within unincorporated Clark County.

Introduction

The Federal Emergency Management Agency (FEMA) has identified in its research and publications that unreinforced masonry structures (URM's) are a type of construction that is particularly susceptible to greater damage or collapse during strong ground motions. In 2012 the Nevada Bureau of Mines and Geology published report 54 "Preliminary Assessment of Potentially Unreinforced Masonry Buildings in Nevada". Report 54 created a database of structures that were potentially believed to be URM's by sorting out building construction types that included masonry. Report 54 provides a description of the methodology utilized in developing the list of "Potential URM's" and also details why we should be concerned about the presence of URM's in Nevada. The list of potential URM's identified that the state of Nevada has approximately 23,597 URM's and that 14,359 of them were within the geographic boundaries of Clark County.

Clark County Department of Building and Fire Prevention (CCDBFP) developed a project scope that would supplement existing staff resources with Student Engineers in a cooperative effort to improve upon and validate the list of potential URM's. The intent of this project is to review, refine and update the present potential URM inventory and to convert this information to a 'validated' URM inventory. The project team will accomplish the following key tasks for the unincorporated areas within Clark County:

- Review the existing potential URM database, check for errors and correct wherever possible;
- Determine if the unreinforced masonry structure still exists by utilizing office research of aerial photography and public records as well as ground proofing;
- Attempt to quantify when the structures are under-reinforced rather than non-reinforced; This cannot be determined visually, but requires specialized equipment.
- Investigate adjacent areas to determine if there are any structures not on the current list that should be included.

The project was partly funded by a FEMA grant which was administered through the Earthquake Engineering Research Institute (EERI). The project became formalized in June of 2014 when EERI and CCDBFP agreed upon the general project scope and timeframe. The project completion was slated for December 31, 2014 which created a fairly tight six month schedule.

Methods

Original Data

An electronic copy of the potential URM database from the NBMG Report 54 was obtained and this proved to be quite helpful as we were able to sort and manipulate the dataset. The data was received as two files, one for residential structures and the other for commercial structures. The two datasets only contained information for potential URM's within Clark County.

The original datasets contained hundreds of data fields for each structure but no metadata was available to describe what this information represented. Several days were spent reviewing this information against records available from the Clark County Assessor's office and we ended up hiding much of the data in the spreadsheet that was not useful for this project's purpose. Some of the more useful data included: assessor's parcel number; street address; municipal jurisdiction; year built. The commercial dataset also contained fields for occupancy description and number of stories.

The two datasets were further segregated by municipal jurisdiction as this project would not cover structures located within the incorporated cities in Clark County. After the sorting, it was identified that the project would attempt to review 647 commercial structures and 4029 residential structures that had been labeled as potential URM's.

Survey Process

Now that the number of structures to be screened had been identified, it was necessary to establish a protocol for how the existing data could be reviewed and validated. The project team reviewed available published literature from prior efforts at screening URM's in Portland, OR and Seattle, WA. FEMA 154 and FEMA P-774 were reviewed and utilized as a basis for creating the protocol used to screen individual structures. It was decided that a simple and rapid method of assessment would be the best choice.

A URM survey form was created and is included as appendix A. The form was designed to serve as a dispatch element in that the first several text boxes are for information to be recorded in the office (location, Unique ID, # stories, year built). When a screener was in the field performing an evaluation the balance of the survey form was utilized to collect data for later entry into the database. Some of the fields are self explanatory and only serve to memorialize the process (screener, date screened, obvious upgrades or remodels).

All structures were assigned to one of six categories during the screening process. These are described below and are intended to help categorize and classify the screening decision which was made.

- **Unable to access**- this choice was selected when a screener was not able to get close enough to a structure to perform a visual assessment. Examples include properties that were fully fenced and/or had landscape or terrain features that precluded direct visual observation. Another example would be when we were explicitly asked to stop the survey by a building owner or occupant. When this selection is made it is hoped that we will be able to gain access in the future and therefore it was important to categorize these structures differently.
- **No structure found**- this choice is selected when a screener was unable to locate a listed structure during the on-site visit. When this selection is made additional effort and research is performed to identify if the structure is actually gone or if a location error exists in the original data. Public records and aerial photography were researched. Where evidence of a demolition permit was found this information is listed in the notes. Reasonable effort was expended to assure that a structure wasn't enveloped by additions or simply missed due to inaccurate location data.

- **URM visual only**- this choice is selected when a screener performed a visual only assessment and determined that the structure was a URM based upon these observations. The Masonry Notes field was used to record information to support this finding. In some instances it is possible to view reinforcing steel where walls have been damaged, repaired or altered.
- **URM visual and tools**- this choice is selected when a screener performed a visual assessment and utilized a rebar detector. . The Masonry Notes field was used to record information to support this finding.
- **Not URM**- this choice is selected when a screener performed a visual inspection and may have utilized a rebar detector to determine that a structure was not a URM. Notes are included to support the decision on what features were utilized to make this determination.
- **Unable to determine**- this choice is selected when a screener was able to obtain sufficient access to perform a visual inspection but was not able to clearly determine if a structure was URM or not. Examples include structures that have received alternate exterior finishes such as plaster, wood/metal/vinyl siding, etc.

The survey form contained fields for recording obvious information regarding falling hazards such as unreinforced masonry chimneys, unreinforced masonry parapets, and masonry cladding/façade. The last field was intended to provide for the taking of notes regarding unique attributes of the observed masonry that assisted in the determination of the category that was selected. Masonry notes included features such as brick/block type, brick/block size, # of withes, wall thickness, lintel type, mortar probe, etc.

The project did employ a unique concept during the screening and data collection that was referred to as clustering. Clustering was more applicable to the residential structures as there were various instances in which entire subdivisions of houses appeared to be constructed identically. Where these conditions were observed the screener would draw a boundary around the cluster group and then proceed to inspect and document every five or so structures. The other structures being similar in nature were assumed to be of the same construction and were labeled as clusters pointing back to the unit that was inspected. This process was not applicable to commercial construction and was not used on residential structures that did not appear to be part of a common development process.

Training

The first step in training the student engineers involved basic education in construction type identification. This included traditional instruction and field trips to help them establish a mental picture how different types of construction look and perform. Specific construction types covered included light frame construction (wood and cold formed steel), structural steel , reinforced concrete, reinforced masonry and of course unreinforced masonry. It is important to understand the basis of how different construction types are assembled and perform as this knowledge can assist in evaluating whether a structure of interest is a URM or if it simply has a decorative masonry veneer or façade.

For the purposes of this survey, a structure was considered to be URM when it has one or more unreinforced masonry bearing walls that support the weight of floors and/or roofs above. Typical traits that can assist in identification of URM's include:

- Solid brick without internal cavities capable of installing reinforcing steel and grout
- Smaller sized brick with evidence of header and stretcher patterns
- Multi wythe construction (thicker walls typically 8 inches thick or greater)
- Arched lintels, lintels of other materials such as wood, steel or precast concrete (URM lintels tend to have a limited span)
- Masonry construction built prior to 1940 is likely to be URM.

It is additionally noted that hollow core block (like CMU) that has a void into which reinforcing steel and grout can be placed tend to not be URM. In some instances damage, repairs and alterations to a building may offer evidence of its construction (i.e. observing exposed reinforcing bars or grout etc.).

Other aspects of training included the ability to perform office research including aerial photography and public records. These tools were effective in locating structures with potential address errors and also in confirming that structures have been demolished. In some instances there is clear evidence of demolition permits and/or photographic evidence to support that a URM structure can be removed from the inventory database. Whenever a structure could not be located in the field, a mandatory step for review of aerial photography and public records was initiated.

The project was performed recognizing the right of refusal to participate in the survey on behalf of a building owner or occupant. While some of the work could be performed visually from the public right of way, some work functions required close access to the structure on private property. There are not currently any state or municipal ordinances to assist with gaining access to complete the survey. Whenever screeners were asked to stop performing the survey, we obliged and moved on to the next structure.

Results

From the original data there were 647 potential commercial URM's and 4029 potential residential URM's. In the process of completing the survey additional structures were identified and some duplication was also observed within the commercial and residential databases. The commercial URM database was increased to 651 to account for four additional URM's that were not explicitly identified in the original list. The residential URM database remains at 4029 but it should be noted that 7 structures were found to be duplicated on the commercial list and should be removed from the residential list and that 7 additional structures were found that were not explicitly identified in the original residential list.

Generalized results are as follows:

Screening Status	**Commercial URM**	**Residential URM**
Unable to access	75 (~11.5%)	123 (~3.1%)
Unable to determine	161 (~24.7%)	695 (~17.2%)
Not URM	313 (~48.1%)	3039 (~75.4%)
No structure found	29 (~4.5%)	27 (~0.7%)
URM visual and tools	11 (~1.7%)	0
URM visual only	39 (~6.0%)	121 (~3.0%)
Incomplete results (needs further review and research)	23 (~3.5%)	24 (~0.6%)

If the preceding statistics are reworked to separate the structures that have been surveyed from the structures that have not been surveyed, then it can be anticipated that there will be 34 additional commercial URM's and 34 additional residential URM's by the time all structures have an actual screening performed. This would place the actual total number of commercial URM's at 84 and the total number of residential URM's at 155. These estimates are speculative and should not be quoted as fact.

Conclusions and Recommendations

Based upon the findings to date, there are fewer URM's present in unincorporated areas within Clark County than originally anticipated. This finding in reasonable given that the original potential URM inventory was prepared with only very generic filtering and included all masonry buildings from assessor's records that had a construction year prior to 1974. Many of the buildings were identified to not be URM's. This project effectively accomplished all of the previously noted key tasks save one. It was originally hoped that it might be possible to determine if a structure was under-reinforced during the screening process. This proved to be a bigger challenge than originally anticipated as some owners/occupants declined to allow access for the survey and in particular they declined permission for the use of rebar detectors. Additionally, in order to call something under reinforced it is necessary to quantify an existing amount of reinforcement and compare it to some standard value. It was not clear what the standard value of reinforcement should be for comparison. The standard could be based upon code requirements at time of construction (difficult to determine) or a percentage of the current code requirements. Gathering of the data on existing reinforcement proved to be too time consuming so this process was not continued for the full duration of the project.

The following is a list of activities that should be undertaken in order to make the best use of the collected data and lessons learned during the project:

- Develop a strategy and continue to complete screening for structures that were not able to be screened during this phase of the project.
- Develop a strategy and attempt to complete screening where exterior finish and remodeling prevented effective visual screening of the structure.
- Pursue additional funding and expand the scope of project to include screening of URM's within the incorporated cities in Clark County.
- Work with other jurisdictions in Nevada (and possibly elsewhere) that may have interest in performing similar URM surveys.
- Prepare documentation of the training and screening process for use by others.
- Prepare a GIS enabled map layer showing the validated database of URM structures.
- Work collectively with state and local officials to determine the next appropriate step in mitigating the potential hazards associated with URM structures.

Suggestions for others wishing to develop their own protocols for URM surveys

Starting with an electronic copy of the original potential URM database provided a very useful starting point for our project. When the databases are sorted by APN, structures in close proximity are listed in succession. With a brief review of location it is possible to select a shift's worth of work that will be in the same general area. This process allowed the screeners to optimize how the survey was approached by minimizing unnecessary trips and travel.

Near the beginning of this project we had looked into the possibility of electronic data collection and geo-tagging of photographs. Given the limited budget and time constraints we opted to perform the data collection and coordination process manually. Electronic integration of the data gathering process should be seriously considered in the future as it will likely improve data collection efficiency and minimize data entry errors.

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Disclaimer

The primary purpose of the surveys completed under this project was to identify if a given structure possessed traits typical of unreinforced masonry construction. This project has not performed detailed inspection and evaluation of the structures nor has any engineering review or analysis been performed. When a structure has been listed as "NOT URM" this simply indicates the screening process has identified traits that are not typical of URM construction or that rebar detectors have been utilized to identify the presence of reinforcing steel. Every reasonable effort has been made to perform the screening in a consistent and uniform manner; given the limitations of the methods used it is not possible to guarantee the absolute correctness of the reported results.

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Appendix A

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URM Survey Form for updating and validating the Clark County URM Database

Location ☐ Check if corrected			
Unique ID ☐ Check if newly ID'd	# Stories	Year Built	Screener
Obvious upgrades or remodels? Notes:			Date Screened

Check one box only

☐ Unable to access (include notes if checked)	☐ No structure found	☐ URM visual only	☐ URM visual and tools
	☐ Not URM (include notes)		
	☐ Unable to determine (include notes)		

Potential Falling Hazards (check all that apply)

☐ Unreinforced Masonry Chimney ☐ Unreinforced Masonry Parapet ☐ Masonry Cladding/Facade

Masonry Notes (Block Type, Block Size, # of Wythes, Wall Thickness, Lintel Type, Mortar Probe, etc...)