

# ADAPTIVE RE-USE AND SEISMIC UPGRADE OF AN UN-REINFORCED MASONRY BUILDING

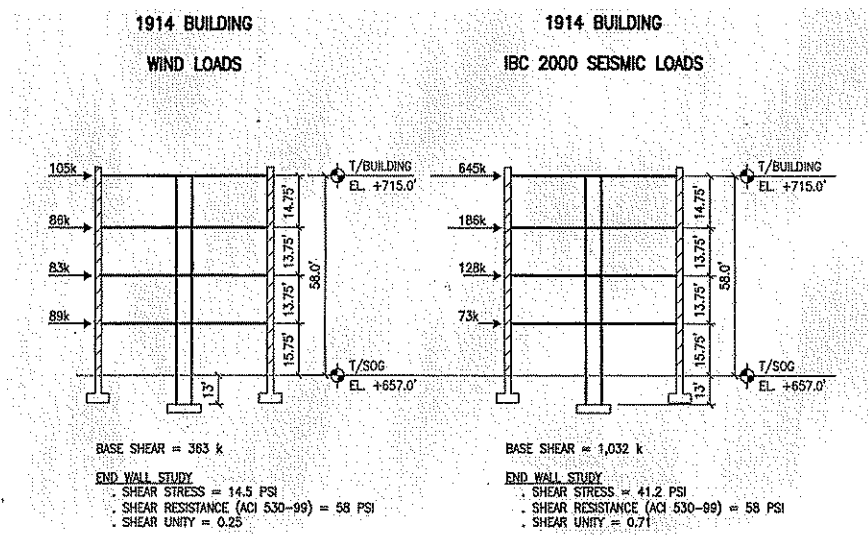
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## ABSTRACT

A four-story unreinforced brick masonry building in Cleveland, Ohio was studied for the purpose of re-use with 20% higher gravity loads, and upgrading the seismic lateral resisting system to comply with IBC 2000 and IEBC 2003 code requirements. This building (named the South Building) was originally built in 1914 as part of a collection of wings that jutted out from a central stem running in the east/west direction. After an extensive feasibility study of all the buildings on the property, the easternmost wing of the Building was identified for rehabilitation, while the remaining portions of the building were to be demolished.

Structural engineering services were provided for the feasibility study, demolition, rehabilitation, and seismic upgrade projects for the South Building. Making this project all the more challenging was the lack of complete original drawings or other documentation. While some drawings were found, many locations within the building did not match the drawing geometry, and no record was found of original material design values. Consequently significant time was spent performing material testing on the structural steel framing members and the un-reinforced brick masonry in order to gain confidence in their load carrying capacity values. In addition, in-situ soil testing was performed on the site in order to satisfy the 20% increase in gravity loads that were being applied to the structure.

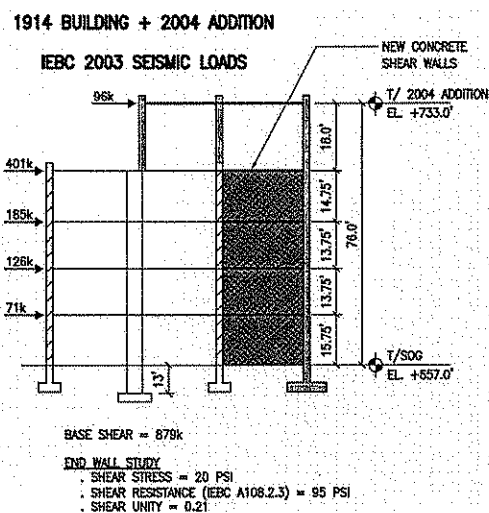
A building structural evaluation was performed on three main areas: the gravity system, the foundation system, and the lateral system. It was found that conventional analysis and upgrade methods could be used to address the gravity and foundation systems. However, the lateral system presented a unique challenge due to the new seismic requirements within the IBC 2000 building code.



**Figure 1 – Lateral Load comparisons on the 1914 South Building.**

The first step in the structural evaluation of the lateral system was to compare the lateral wind loads likely used in the original building design in 1914 with the City of Cleveland Code requirements at present day (refer to Figure 1). The City of Cleveland Code references IBC 2000.

The results show that the minimum code required design loads that the 1914 South Building must resist has increased by up to 200% due to new Code requirements. This is much larger than the 5% overstress limit permitted for renovated structures by IBC Section 1614. Therefore, it was determined that retrofit of the existing system would be untenable, and a new lateral load path must be developed in order to meet the code requirements to renovate this building.



**Figure 2 – Lateral Load on the 1914 Building plus new addition with concrete shear walls.**

The primary seismic upgrade system was to tie a new 2,790 m<sup>2</sup> (30,000 square feet) building along the West side into the existing portion of the South Building (refer to Figure 2). This addition includes seven reinforced concrete shear walls that become the new primary lateral resisting system. The ductility of the entire system (R=1.5) was limited to that of the existing un-reinforced masonry bearing walls to ensure compatibility. The engineers also took advantage of the newly issued IEBC 2003 code provisions for “Seismic Strengthening Provisions for Un-reinforced Masonry Bearing Wall Buildings”. Best of all, the added square footage increased the real estate value of the building, and helped offset the cost of the renovation.

### AUTHOR'S INFORMATION

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