SEISMIC RETROFIT OF CONFINED MASONRY HOUSES IN HAITI: LESSONS FROM IMPLEMENTATION

16TH WORLD CONFERENCE ON EARTHQUAKE ENGINEERING
SANTIAGO, CHILE

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Paper No. 3888
Housing in Urban Haiti
January 2010 Earthquake

Source: CNBH 2012
Development of Evaluation and Retrofit Procedures

- Checklist-based approach
- Check on lateral system capacity based on Wall Area Percentage
- Performance criteria: structural life-safety in design EQ
- Applicable to typical masonry houses, up to 3 stories depending on seismicity and building type
- URM or CM
## Development of Evaluation and Retrofit Procedures

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Wall Area Percentage Retrofit Options

Add Wall Capacity
- New masonry walls
- Infill existing openings
- Strengthen existing walls with overlays

Reduce Demand
- Increase ductility by converting URM to CM
- Reduce mass by removing a level
- Reduce mass by replacing a heavy roof with a light one
Homeowner-Driven Retrofitting Experience in Haiti
Example Project – Campeche, Carrefour Feuille

224 projects for 500 families retrofit or also expanded.

2011

2016
Example Retrofit

Existing

Retrofit
Example Project – Campeche, Carrefour Feuille

Retrofitting is cost-effective

- Average cost: $130/m²
- New construction average cost: $250/m² + demo + rental or temporary shelter
- Average housing units per building: 2.5 (minimum of 1 to maximum of 9)
- Higher costs inflated by other work - required layout reconfigurations due to adjacent public infrastructure works performed at the same time
- Costs include average 7% increase from pre-construction budget estimates
Technical Decisions in Implementation

Replace or repair?

- Existing masonry walls
- Existing concrete slabs
- Existing confining elements
Ensuring Quality Construction

- Construction Quality Checklists
  - completed by the engineer for each work item
  - reviewed by government engineer
- Covers materials and methods
Training the Actors in the Construction Value Chain
Window Intil

1. Add timber to support the side from below before starting any demolition work.

2. Remove the window grill and roughen the vertical edges of the wall on either side of the opening.

3. A good connection between the wall and the concrete can either be achieved by breaking out existing mortar on the wall edges or by drilling holes into the ends of the block.

4. Thoroughly roughen the underside of the slab. This will improve the connection between the wall and slab.

5. Place blocks to fill the space on the opening of the window. Use all of the normal rules of blocklaying (see pgs. 16-19).

6. When building the wall, make sure to leave a space between edge of the slab and the existing wall. Concrete must be able to flow through this space.

7. When laying the last course of blocks, make sure to leave a gap of 4cm to 7cm between the top of the block and the underside of the slab. Treated, partial height blocks can be used to achieve this.

8. Fill the space between the slab and existing wall with concrete. As shown on the next page there are multiple ways to do this. Choose the appropriate method to execute this step.
Training the Actors in the Construction Value Chain

Block producer training
Training the Actors in the Construction Value Chain

Homeowner Education

Engineer Training
Conclusions

- Retrofitting damaged houses can be time and cost effective.
- Retrofitting can be done with local materials and skills.
- During evaluation it is critical to identify the condition of key elements, like walls, slabs and tie columns.
- Retrofitting projects provide the opportunity to reinforce key elements of the safe construction value chain.