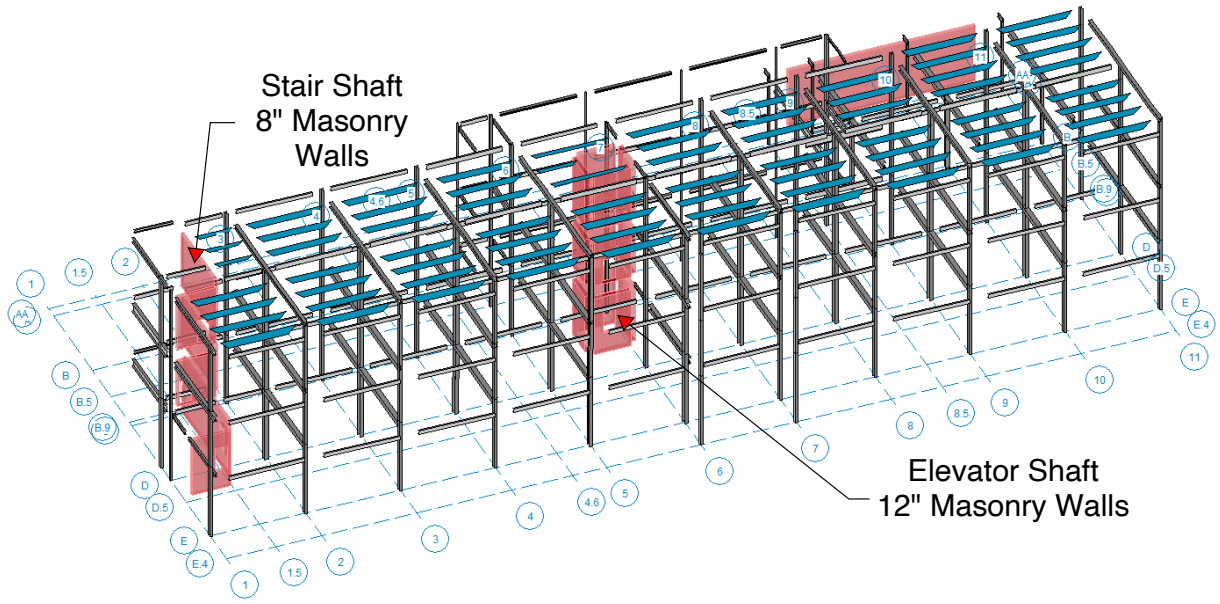
MASONRY INSIGHTS

written in conjunction with International Masonry Institute

Case Study: Utilize Masonry Walls to their Full Potential



This article will step through a review of a multi-story steel and masonry project structural review, and ways to increase efficiency in its structural systems.

Contractor: The masonry stair and elevator shaft walls in the above project are being used by the architect/engineer design team as impact resistant, durable, and fire resistant walls. The walls are also resisting gravity floor and roof loads. Are there other ways the masonry walls can be utilized?

Reviewer: In reviewing the project, it seems masonry is being utilized well. There does seem to be one area of improvement. The masonry walls are tied into the floor and roof framing with beams and diaphragm members connected to the masonry walls. The masonry walls will then participate in, and serve as the primary members in resisting the building lateral loads. However, there are many steel moment frames and steel braced frames also specified. Our initial thought, which was confirmed by a thorough analysis, was that the masonry walls would take a substantial portion of the lateral load and that the contribution of the steel members would be minor due to greater masonry wall stiffness. Our final analysis showed that the masonry walls on the project could have taken the full lateral load with minor changes, which would have allowed for cost savings for all other lateral elements. In other words, all the steel moment frame connections (estimated 108 moment connections) and braced frame members (6 steel braces and 12 gusset frame connections) could have been significantly reduced, or possibly eliminated.

Where to Consider Using Structural Masonry?

Framing Checklist for Building Locations Where CMU Assemblies Could Be Used:

- [x] Foundation walls
- [ ] Basement walls - *no basement on this project*
- [x] Stair and Elevator Shaft walls
- [ ] Exterior Bearing walls - *all glass exterior, no exterior walls on this project*
- [x] Interior Bearing walls - *stair and elevator walls are used for gravity load bearing*
  - [ ] Lateral resistance - *opportunity for improvement, bearing walls can resist gravity & lateral*
- [ ] Interior Partition walls - *no partition walls on this project*

Where to Use Structural Masonry?

Where to use Structural Masonry?	BUILDING SYSTEMS				
	WOOD	COLD-FORMED STEEL	STEEL	CONCRETE /PT CONC	PRECAST
FoundationWalls	✓✓	✓✓✓	✓✓✓	✓	✓
Basement Walls	✓✓	✓✓	✓✓	✓	✓
Shear/Shaft Walls	✓✓✓	✓✓✓	✓✓✓ HYBRID	✓✓ HYBRID	✓
Exterior Bearing Walls	✓	✓	✓✓ HYBRID		✓✓✓
Interior Bearing Walls	✓	✓	✓✓		✓✓✓
Interior Partition Walls			✓	✓✓✓	✓✓✓

FORSE

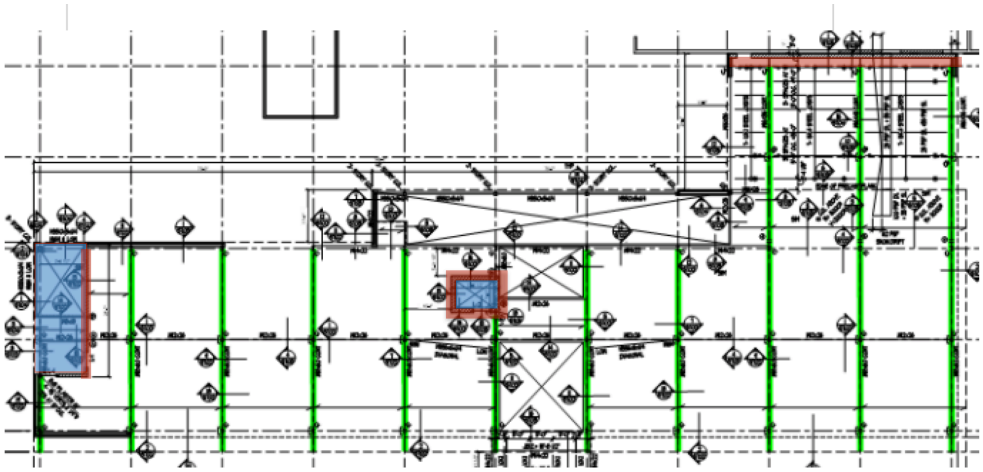
Original Project

Masonry System

- Stairs (not used for lateral): 8" masonry walls with #5@24" o.c. vertical reinforcement
- Elevators (not used for lateral): 12" walls with #5@24" o.c. vertical reinforcement
- f'm = 1750 psi

Steel System

- Steel beams, roof joists, and columns for gravity
- 11 Moment Frames in the N-S direction and 2 Braced Frames in E-W direction



Revised and Updated Project

Masonry System

- Stairs (designed for gravity & lateral): SAME 8" masonry walls with #5@24" o.c. vertical reinforcement
- Elevators (designed for gravity & lateral): SAME 12" walls with #5@24" o.c. vertical reinforcement
- Additional #5 @40" o.c. horizontal reinforcement, for added shear resistance & eliminate control joints
- f'm = recognized actual capacity of 2500 psi

Steel System

- Keep steel beams, roof joists, and columns for gravity
- *Saving*: Remove: 11 Moment Frames (108 connections) and 2 Braced Frames (6 braces/ 12 connections)

Masonry Check List

General Checklist for Masonry Assemblies:

- [x] f'm (masonry assembly strength) is 2,000 psi or greater
  - [x] ideally in Midwest it should be 2,500 psi
  - [ ] strengths between 2,000 to 4,000 psi are permitted in current codes[1]
- [x] check that all components of masonry are specified
  - [x] block strength (check www.forsei.com/cmudata to verify based on project location)
  - [x] mortar type (mortar strength need not be listed)
    - [x] recommend Type S for structural walls
    - [ ] recommend Type N for non-structural walls (partition walls)
  - [x] grout strength
    - [x] should be at least 2,000 psi, and equal to or greater than f'm
- [x] check that control joints (CJ)'s are located on plans
  - [x] CJ's in reinforced structural walls
    - [ ] at common wall locations [2]: generally at 25 ft spacing or less, change of wall height, building corners
    - [x] at a distance (recommend 2 ft) away from opening edges[3], not at opening edges
  - [ ] CJ's in unreinforced non-structural masonry walls
    - [ ] at common wall locations [2]
    - [ ] at openings edges [4]
  - [x] CJ not needed when sufficient horizontal reinforcement [5] is provided
  - [x] review lintels, and prefer masonry
  - [x] masonry lintels are considered first for ALL openings
    - [x] openings 8" or less do not need a lintel
    - [x] openings 4'-0" or less could be a single-course masonry lintel with minimal reinforcement, and jamb could be one cell with common wall reinforcement

- ☑ openings more than 4’-0”
  - ☑ consider masonry lintel as the first option
    - ◆ consider multi-course masonry lintels
    - ◆ consider stirrups in masonry lintels when deeper lintels are not possible
  - ☐ consider prefab masonry lintel (contractor option)

REFERENCES

[1] - current masonry code is TMS 602-16

[2] - based on NCMA TEK 10-2C (2010) or TEK 10-3

[3] - based on NCMA TEK 10-2C (2010), Figure 2c or Figure 2d (page 3)

[4] - based on NCMA TEK 10-2C (2010), Figure 2a or Figure 2b (page 3)

[5] - based on NCMA TEK 10-3