MASONRY INSIGHTS

written in conjunction with International Masonry Institute

Case Study: Fire Station with Masonry Lintels

Contractor: I would like the masonry reviewed for the Eau Claire Fire Station.

Reviewer: I would suggest starting with these 5 items to be addressed.

First item, I'd start with getting more accurate material strengths defined for masonry.

MASONRY

1. MASONRY CONSTRUCTION SHALL MEET THE REQUIREMENTS OF THE BUILDING CODE.
2. ALL HOLLOW CONCRETE MASONRY UNITS SHALL CONFORM TO ASTM C90, NORMAL WEIGHT, TYPE 1, MOISTURE CONTROLLED. MINIMUM REQUIRED BLOCK COMPRESSIVE STRENGTH IS ~~1,900 PSI.~~ 3,750 PSI
3. GROUT SHALL CONFORM TO ASTM C476, FINE GROUT. MAXIMUM SIZE OF AGGREGATE SHALL BE 3/8 INCH. FLY ASH AS A PERCENTAGE OF TOTAL WEIGHT OF CEMENTITIOUS MATERIAL SHALL NOT EXCEED 40 PERCENT PER ASTM C595. FLY ASH SHALL BE CLASS C OR F, MEETING ASTM C618 REQUIREMENTS. SLUMP SHALL BE 8 TO 11 INCHES. WATER-REDUCING ADMIXTURES MAY BE USED. MINIMUM GROUT COMPRESSIVE STRENGTH BASED ON 28-DAY TESTS SHALL BE ~~2,000 PSI~~ AND GREATER THAN OR EQUAL TO THE SPECIFIED MINIMUM DESIGN STRENGTH.
4. ALL UNITS SHALL BE LAID IN RUNNING BOND USING TYPE S MORTAR WITH HEAD JOINTS.
5. REQUIRED MORTAR PROPORTIONS BY VOLUME:

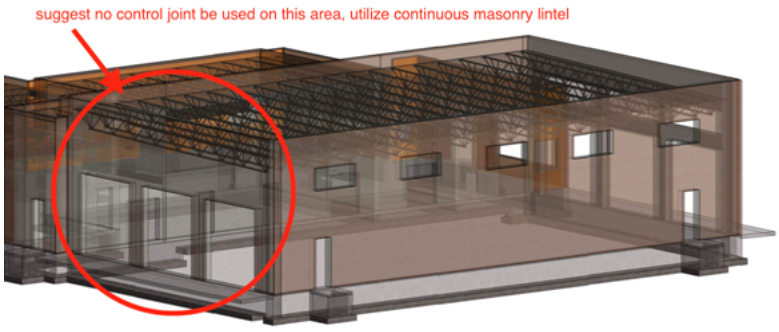
TYPE	PORTLAND CEMENT	HYDRATED LIME	AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION
S	1	OVER 1/4 TO 1/2	NOT LESS THAN 2 1/4 AND NOT MORE THAN 3 TIMES THE SUM OF THE VOLUMES OF THE CEMENT

6. MASONRY MINIMUM DESIGN STRENGTH IS f'm = ~~1,500 PSI.~~ 2,500 PSI
7. ~~ALL BELOW GRADE MASONRY SHALL HAVE ALL CORES FILLED SOLID~~ WITH CONCRETE GROUT.

Second item, I did not see CJ specified, they need to have CJ for masonry identified on structural drawings.

Third item, I would strongly suggest CJ be located away from openings for a majority of the building, see page 3 of the attached: http://www.ncma-br.org/pdfs/5/TEK%2010-02c.pdf

Fourth item, I would suggest no CJ be located on each end of the station where the openings for the trucks are located. Masonry lintels should be used to span all openings as a continuous beam. This is based on this NCMA document: http://www.ncma-br.org/pdfs/5/TEK%2010-03.pdf



Fifth item, I would strongly suggest masonry lintels based on the multiple attached documents, see attached:

- My presentation slides can be viewed by selecting the link:
  - https://app.box.com/s/3erc2lcmj3w54tg80215s29huvo6nrkf
- NCMA manual for Masonry Lintels:
  - http://ncma-br.org/pdfs/masterlibrary/TR91B%20Lintel%202004%202012.pdf)
- NCMA TEK for ASD of Masonry Lintels:
  - http://ncma-br.org/pdfs/30/TEK%2017-01D1.pdf

Please let me know if you need any help. As I mentioned in the seminar, I can design all of the masonry lintels, but I'd rather help the engineer understand the benefits.
Also, I could list more items, but I think these 5 items are essential.

Final Project

Check List

- [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
    - [x] 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)

☑ consider the following for steel lintels:

- ☐ vertical reinforcement location, generally needs to more one of more cells away from opening
- ☐ torsional effects, especially with steel wide flanges with virtually no torsional capacity
- ☐ for bearing plates, compatibility with block shapes used
- ☐ thermal bridging, architectural challenge with building insulation envelope
- ☐ thermal bridging, structural challenge with differential thermal movement between steel and masonry
  - ◆ differential movement between steel and masonry, even after building is insulated and occupied, will cause very large forces unless steel is allowed to move relative to masonry
  - ☐ one method for accommodating thermal movement is to use control joints at one or both ends of the steel lintel, which reduces wall and lintel effectiveness, but is necessary for differentially moving material
- ☐ consider the masonry soaps (thin masonry shells) used to cover the steel
  - ☐ are they able to be cut to fit the steel section (or steel section and bottom plate)
  - ☐ are they durable to building use conditions
  - ☐ no connections are allowed on masonry soaps

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