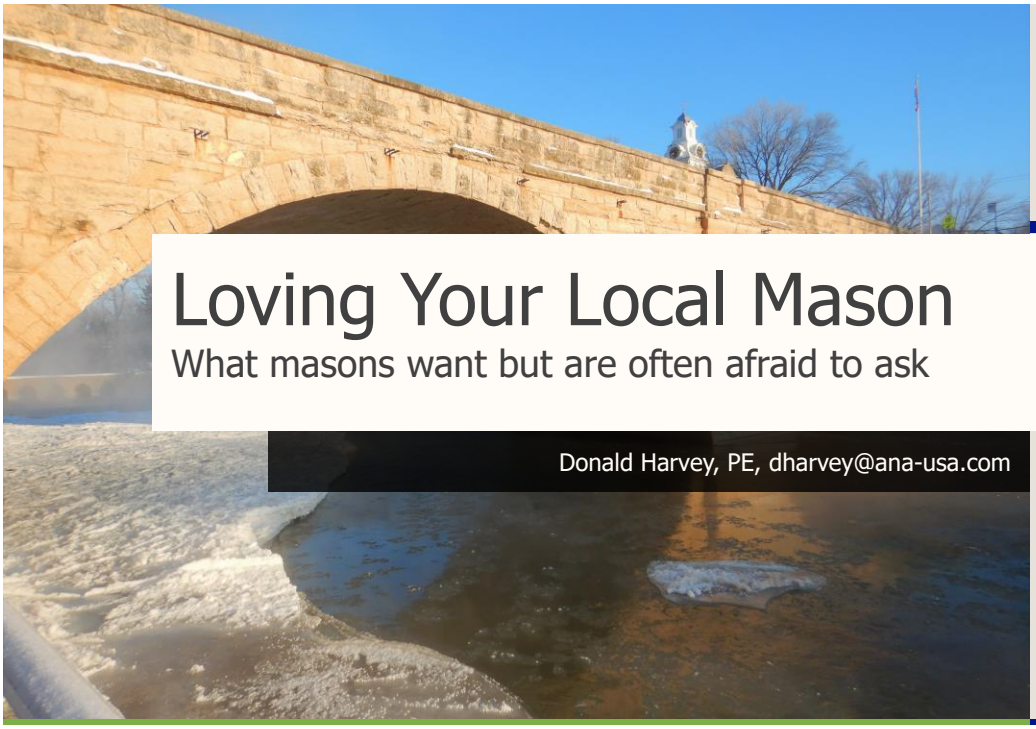


Loving Your Local Mason

What masons want but are often afraid to ask

Donald Harvey, PE, dharvey@ana-usa.com

NCSEA
National Council of Structural Engineers Associations

Atkinson Noland & Associates
www.ana-usa.com

1

Copyright Materials

Atkinson-Noland & Associates

2

Learning Objectives

After completing this webinar, attendees should have a better understanding of the following:

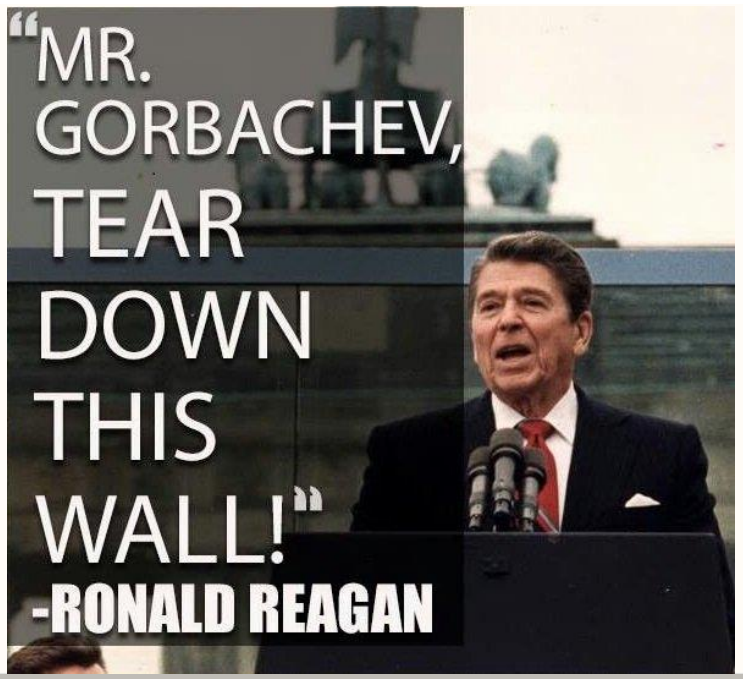
1. What types of detailing and drawings are most beneficial to masons
2. Where bar congestion is most problematic
3. Why coordination between masons and other trades can be problematic

Outline – Loving Your Local Mason

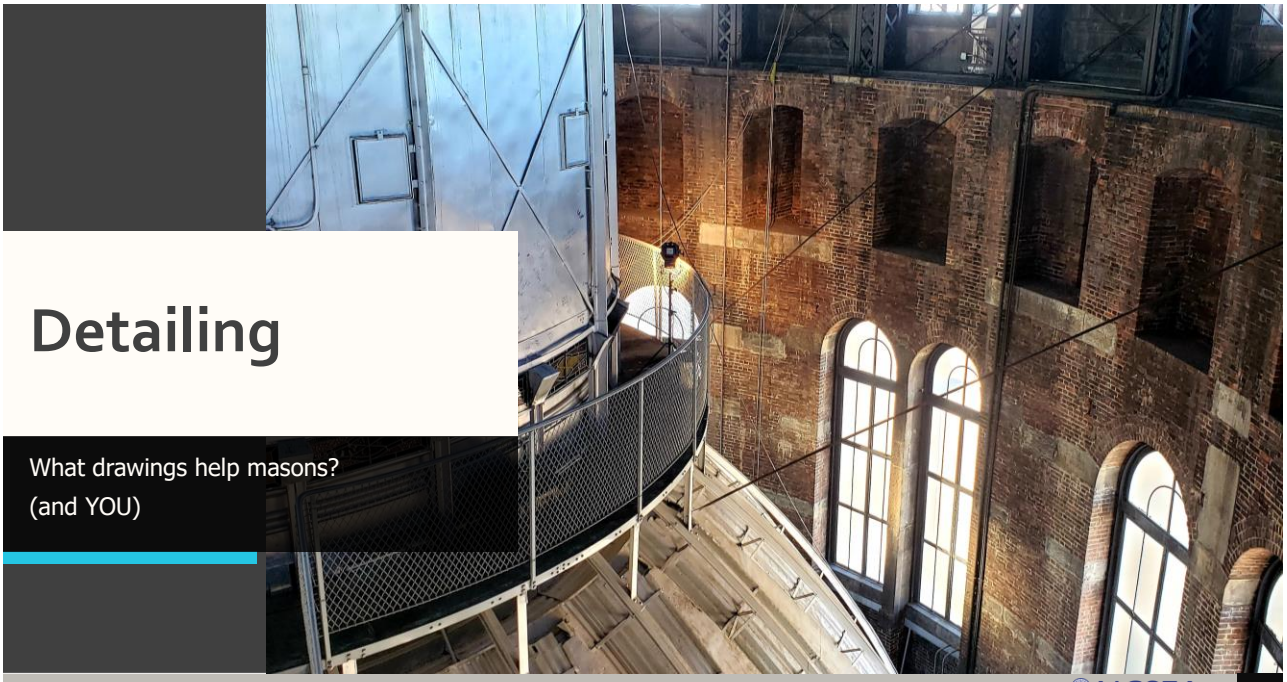
- Detailing
- Bar Congestion
- Different Materials and Trades
- Other Stuff


Are big, strong masons really afraid of ME?!
Why?

5


"MR. GORBACHEV, TEAR DOWN THIS WALL!"
-RONALD REAGAN

6



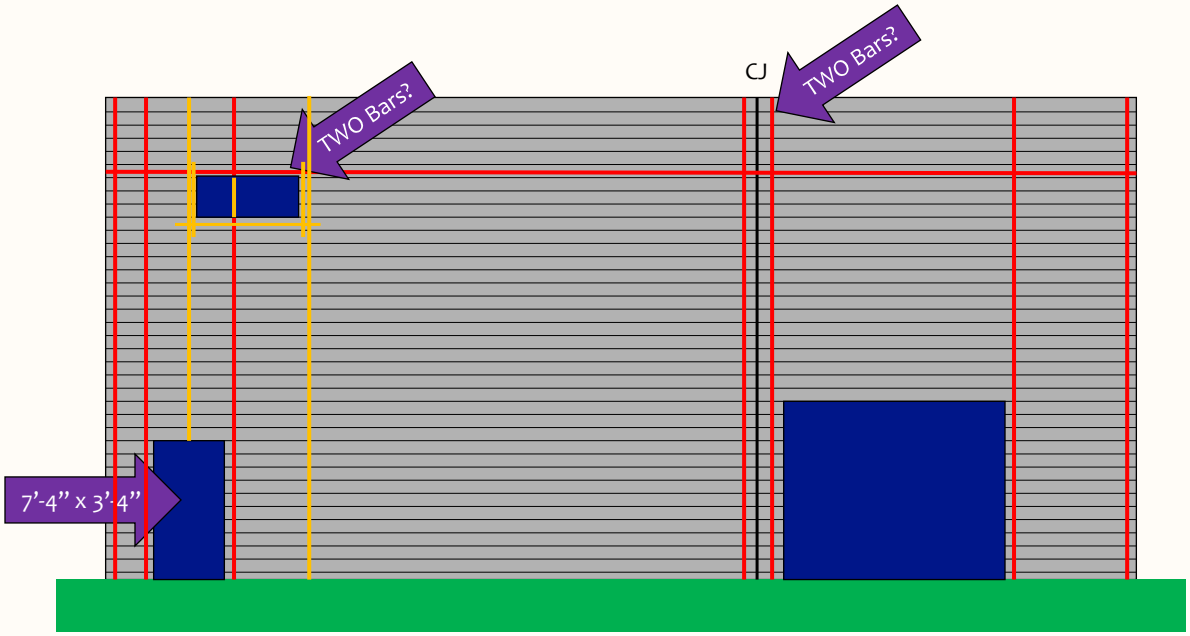
Detailing

What drawings help masons?
(and YOU)

Detailing

- What is often provided:
  - Plan view or section with typical reinforcing (or note)
  - Corner note
  - Bond beam note
  - Shear wall schedule
  - Lintel Schedule (if present)
  - Joint spacing (often text only)
  - Reinforcing adjacent to joints (usually note)
  - Jamb reinforcing (often a note or isolated detail)

Potential Conflicts:
- **Bond Beams and Lintels and Shear Reinforcing**
- **Vertical Bars and Corner Verticals and Joint Verticals**



9

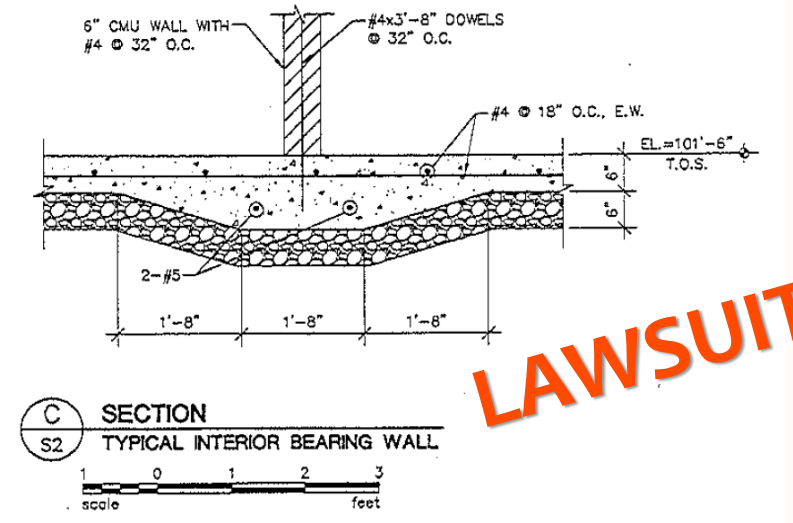
How can your design address all of these potential conflicts?

Hint: I just showed you…

10

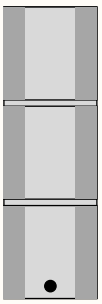
Image courtesy of Larsen Structural Design of Fort Collins, Colorado

Detailing: Adequate Detail



LAWSUIT!

Detailing

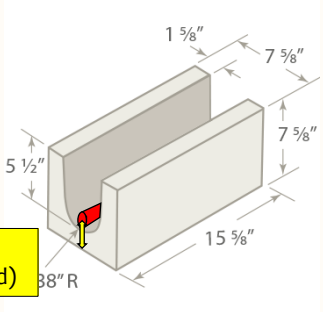


Include important engineering information

on your drawings!

(When is the last time you saw a mason carrying around a Spec Book?)

- What about partition walls?
- Ambiguous language: "Grout all cells solid" (just the cells shown to be grouted on the drawings or every cell in the structure?)
- Lintel **section** details



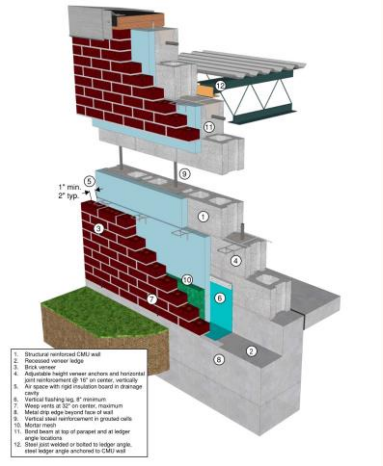
2 3/8" **MINIMUM**
(With 1 #4 bar centered)

Detailing

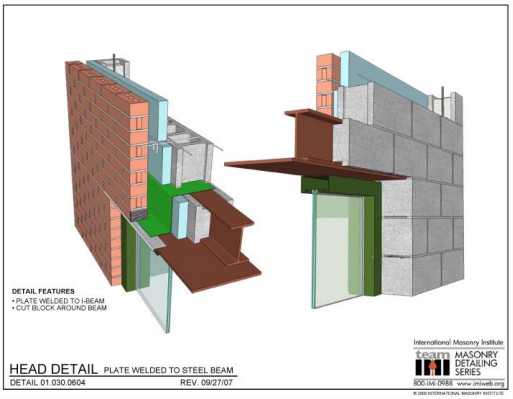
- f'_m – masonry design compressive strength
  - 2013 Code Update – What are you using?
    - 2000 psi block (minimum)
    - Type N mortar (minimum/recommended)
    - **f'_m = 1740 psi (minimum)**
    - Grout strength ≥ f'_m
- Reinforcement
  - Size
  - Location - in plan, elevation, section
  - Location – "d" distance within wall thickness
- Control joint **location**, not just spacing

Detailing: Use Resources

www.rmmi.org/top-10-masonry-wall-systems/



www.imiweb.org



Bar Congestion

Those dots are not dots!

Bar Congestion: Manageable Reinforcing

- Survey on bar size and spacing

Bar Size	Spacing (inches on center)
#3	8
#4	16
#5	24
#6	32
#7	48

All of these combinations provide 0.15 to 0.165 square inches of steel per foot.

Bar Congestion: Manageable Reinforcing

- Survey on bar size and spacing

Consider using the same bar size for lintels and bond beams to avoid confusion on site. OR odds/evens

Bar Size	Spacing (inches on center)	Preferred Masons	
#3	8	0%	
#4	16	0%	
#5	24	78%	
#6	32	22%	Second Choice for Most
#7	48	0%	Laps and Weight

What Masons Want: Constructible Drawings

Two #6 vertical bars plus a #6 dowel is TOO MUCH!

- Congestion!
- MSJC Section 3.3.3 (cont.)
  Reinforcement requirements and details
  - Reinforcement area <= 4% of cell area
    (<= 8% @ splice location)

USE **ONE** BAR CENTERED IN THE CELL

... or carry a weapon when you visit the jobsite ...

Bar Congestion

- One Bar: Other Advantages

8" CMU, 1740 psi f'_m

Bar No.	Lap Length, inches
3	21
4	37
5	58
6	109
7	149
8	224
9	286

LOW LIFT PROBLEM

Bar at face shell – cover = 1.25"

What f'm are you using? Have you updated your lap tables?

Bar No.	Lap Length, inches
3	12
4	13
5	21
6	40
7	55
8	85
9	110

centered in cell

Multiple Bars in a Single Cell: (In)efficiency Analysis

- Two scenarios for a 23'-0" wall:

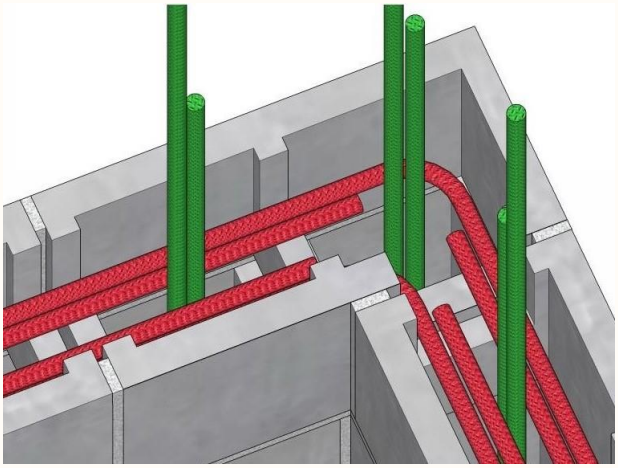
	One #5 Bar Centered in Cell	Two #5 Bars One at Each Face
Lap Length	21"	58"
Capacity	5800 ft-lb	9700 ft-lb 69% Increase
Weight of Rebar Used	33 lb.	98 lb. 197% Increase!!!

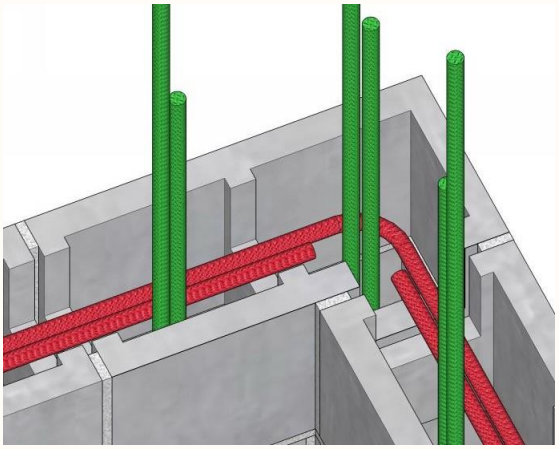
Efficient Placement?

Bar Congestion

- "Reinforce all masonry walls with 2 - #5 in horizontal bond beams @ 4'-0" O.C."
- Use 1 – bar bond beams wherever possible
- Bond beams at 4'-0" O.C. necessary?

Bar Congestion



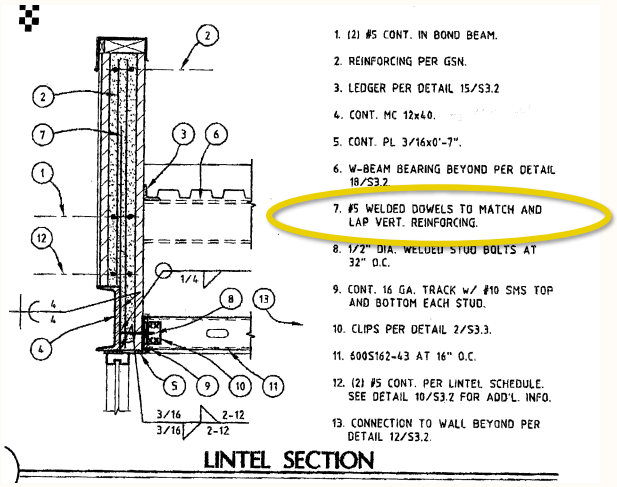


Different Materials and Trades

Everyone plays nicely together… right?

Different Materials and Trades

- Welding and Embedded Steel



Potential Conflicts:
- Schedule/coordination
- Tolerances
- Cutting and Soaps

Different Trades

- Welding / Embedded Steel Framing
  - Different Trade – Coordination/Delay
  - How does it affect masonry installation
  - Soaping around framing
  - Bottom Line: **Avoid if possible!**
- **USE MASONRY LINTELS!**
  - Also helps with thermal bridging and compatibility
  - Virtually ANY span is possible

Other Trades – Wood?

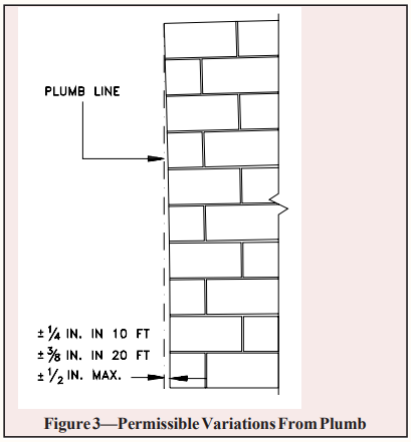


Figure 3—Permissible Variations From Plumb

Tolerances for Wood Framing?

Other Stuff

Bonus Content!

Other Stuff: Local Materials

- Know your local materials (don't be afraid to ask)
  - Grout 2000 psi or 3000 psi?
  - Block **lightweight or normal weight**
    - L.W. 28-35 lb. vs. N.W. over 44 lb.!
    - Minimum 20% increase in cost.
    - Worse fire resistance
    - What about water resistance?
  - Typical block compressive strength
  - Self-consolidating grout availability
  - Low-alkali cement?
  - Preblended vs. site-batched mortar
    - Site-batched mortar generally has higher strength per type … Why?
  - Low-lift vs. High-Lift Grouting?

NOT YOUR JOB!

Other Stuff: Testing

- What do Type S and N mortar stand for?
- **You should want WEAK mortar!**
- Mortar cube testing is NOT REQUIRED and USUALLY COUNTERPRODUCTIVE!

Other Stuff: Testing

- Most "Low Breaks" are due to lab error in our experience.
- NO TESTING is required for unit strength method.
- Read Appendix X1 of ASTM C270, where Type N is the RECOMMENDED mortar for load-bearing walls!

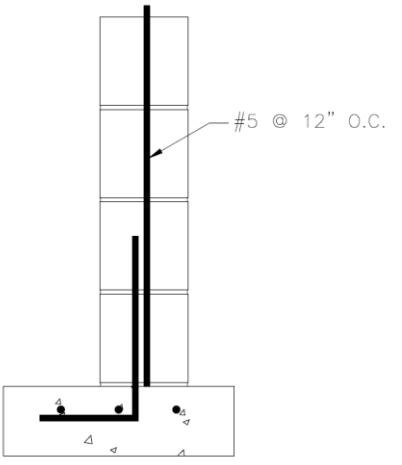
Don't OVER-test!

How many bolts did you test on your last project?

Other Stuff: Modular Construction

What's wrong with this detail?

- Don't rely on your concrete experience
- Reinf. has to follow modular layout
  - 8" module



Other Stuff: Unit Strength

"Recalibration" of concrete masonry unit strength tables

- Provides greater assembly compressive strength f'_m
- Why?
  - Old tables based on highly variable test data: 1950's – 1980's
  - ASTM C1314 – unified prism testing beginning in 2000
  - Current data statistically more consistent

From NCMA Research Report

- Unit Strength Table 2: Concrete Masonry

2011

Net area compressive strength of concrete masonry units, lb/in.^{2} (MPa)		Net area compressive strength of masonry[A], lb/in.^{2} (MPa)
Type M or S Mortar	Type N Mortar	
---	1,900 (13.10)	1,350 (9.31)
1,900 (13.10)	2,150 (14.82)	1,500 (10.34)
2,800 (19.31)	3,050 (21.03)	2,000 (13.79)
3,750 (25.86)	4,050 (27.92)	2,500 (17.24)
4,800 (33.10)	5,250 (36.20)	3,000 (20.69)

[A] For units less than 4 in. (102 mm) in height, 85%

2013

Net area compressive strength of concrete masonry, psi (MPa)	Net area compressive strength of concrete masonry units, psi (MPa)	
	Type M or S mortar	Type N mortar
1,700 (11.72)	---	1,900 (13.10)
1,900 (13.10)	1,900 (13.10)	2,350 (14.82)
2,000 (13.79)	2,000 (13.79)	2,650 (18.27)
2,250 (15.51)	2,600 (17.93)	3,400 (23.44)
2,500 (17.24)	3,250 (22.41)	4,350 (28.96)
2,750 (18.96)	3,900 (26.89)	-----
3,000 (20.69)	4,500 (31.03)	-----

[1]For units of less than 4 in. (102 mm) nominal height, use 85 percent of the values listed.

Use Mockups & Include Structure

- Mockups
- Mockups SHOULD BE for Engineers, too!
- MSJC Spec, 1.6 D, Sample Panels:
  - "Retain sample panels at the job site until Work has been accepted"
- Do not destroy it until all contracts have been paid

DON'T put control joints at openings!

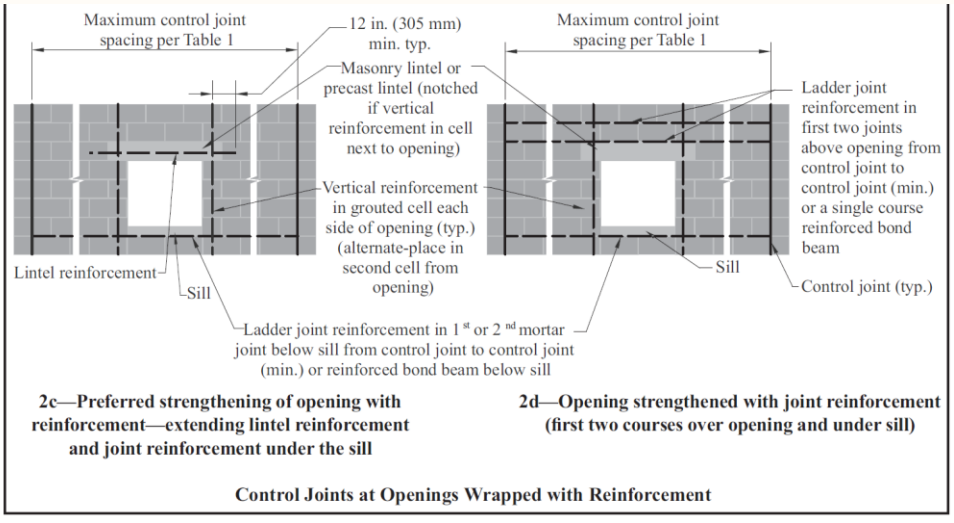


Figure 2—Control Joints at Openings

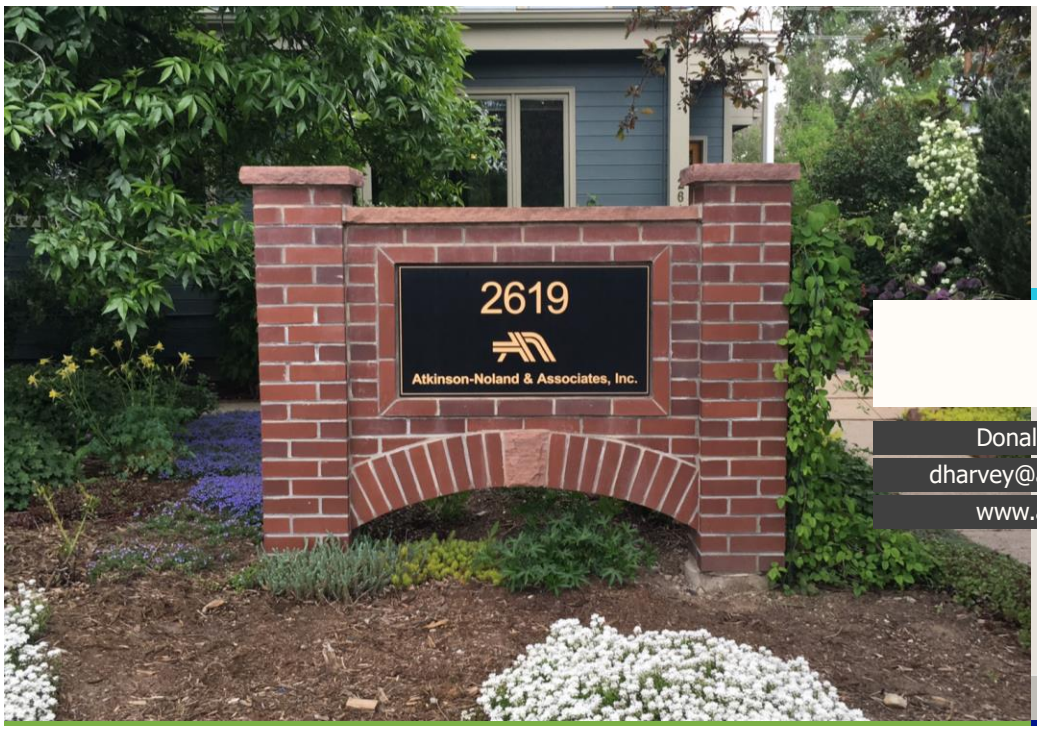
OR don't put in control joints AT ALL?!

- Go to ncma.org
- Find "TEK 10-03 CONTROL JOINTS FOR CONCRETE MASONRY WALLS – ALTERNATIVE ENGINEERED METHOD"
- Makes sense for walls with lots of openings.

Table 3—Maximum Spacing of Horizontal Reinforcement to Meet the Criteria As > 0.002An[1]

Wall thickness, in. (mm)	Maximum spacing of horizontal reinforcement, in. (mm) Reinforcement size		
	No. 6 (M19)	No. 5 (M16)	No.4 (M13)
Ungrouted or partially grouted walls			
6 (152)	48 (1219)	48 (1219)	32 (813)
8 (203)	48 (1219)	40 (1016)	24 (610)
10 (254)	48 (1219)	32 (813)	16 (406)
12 (305)	48 (1219)	24 (610)	8 (203)
Fully grouted walls			
6 (152)	32 (813)	24 (610)	16 (406)
8 (203)	24 (610)	16 (406)	8 (203)
10 (254)	16 (406)	16 (406)	8 (203)
12 (305)	16 (406)	8 (203)	8 (203)

1. A_n includes cross-sectional area of grout in bond beams



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