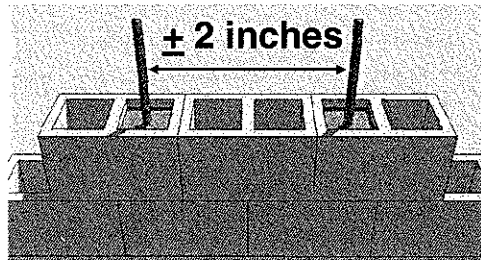




## Placement Tolerances for Vertical Reinforcement in Walls

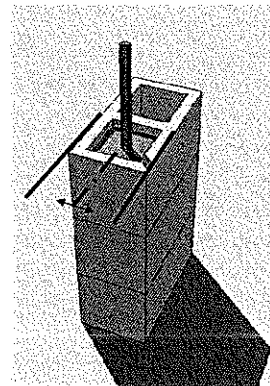
- Measured along the length of the wall.
- Placement tolerance is  $\pm 2$  inches.
- For example, 24" o.c. could vary from 22" o.c. to 26" o.c.



## Placement Tolerances for Rebar

Measured from compression face:

- For depth equal to or less than 8" =  $\pm \frac{1}{2}$  inch
- For depth greater than 8" but less than 24" =  $\pm 1$  inch
- For 24" or more =  $\pm 1 \frac{1}{4}$  inch

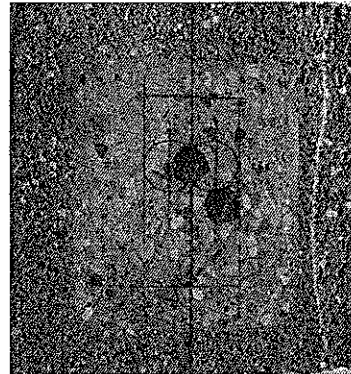




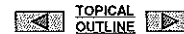
## Placement Tolerances - Rebar

This sample cut from a demonstration panel shows the window allowed by the tolerances for rebar placement for  $d \leq 8"$ .

The tolerance would be  $\pm \frac{1}{2}"$ , measured from specified position  $\frac{1}{2}"$  in either direction to the center of the rebar.



The rebar on the center line was in the rod positioner, the slightly off set rod is the dowel from the footer. Notice the grout. SCG was used for this demo panel.

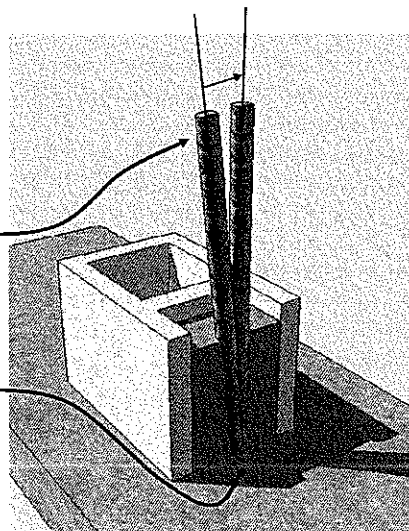


## Dowel Alignment

It is permissible to bend dowel 1 inch horizontally for every 6 inches of dowel height.

Inserted lapped rebar should have full and direct bearing on footing.

If dowels are too far out of alignment, notify the architect /engineer.





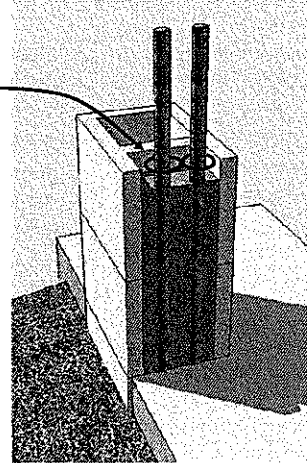
## Minimum Masonry Cover

Grout should be able to flow completely around the rebar.

Clearance must be provided between the:

- Face shells of the CMU
- Other rebar

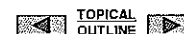
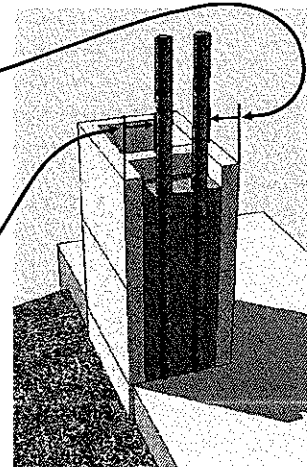
Masonry & grout coverage also protects the rebar from corrosion or weather.



## Minimum Masonry Cover

1 1/2 inch minimum cover for interior face.

2 inch minimum cover for exterior face exposed to earth or weather.

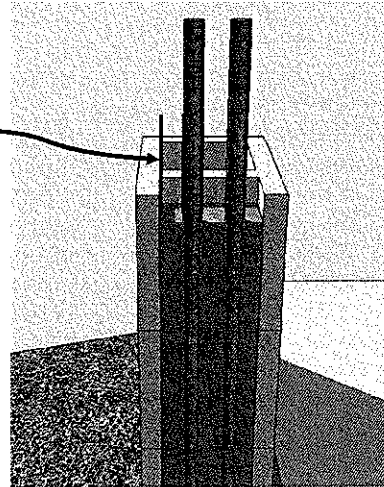




## Minimum Grout Clearances

Minimum clear distance:

- $\frac{1}{4}$  inch for fine grout
- $\frac{1}{2}$  inch for coarse grout

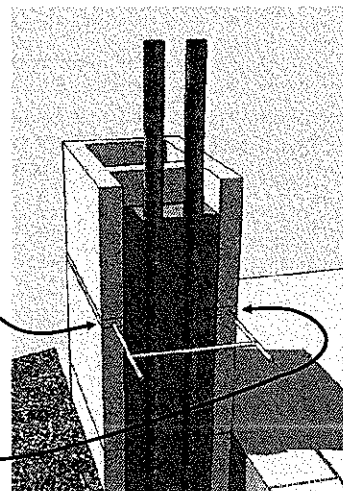


TOPICAL  
OUTLINE



## Minimum Joint Reinforcement Cover

- Joint reinforcing must be embedded in mortar  $\frac{5}{8}$ " when exposed to weather or earth.
- Joint reinforcing must be embedded in mortar  $\frac{1}{2}$ " when not exposed to weather or earth.



TOPICAL  
OUTLINE



# Chapter 4

## Grout Placement Requirements



### Grout Terminology

- Pour..... Total height of masonry to be grouted prior to the erection of additional masonry.
- Lift ..... Amount poured at one time in a single operation  
(many lifts = single pour)
- Cementitious .... Cement and lime
- Segregation ..... Separation of ingredients  
(not desirable)





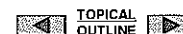
## Grout

- **Grout is NOT mortar NOR concrete** and is a cementitious material unique to masonry.
- Grout can be mixed on-site or obtained from transit or Redi-mix suppliers or can be supplied in dry silos systems or bagged.
- Grout can be placed by hand or pumped with specifically designed grout pumps.
- Grout quantities can be determined from reference charts such as the one shown on the next slide.



Standard 2-cell CMU	Grouted Cells Vertical Bar Spacing	Cu. Yds. of Grout per 100 CMU (6' x 16' x 16')
6" thick walls	All cells filled	0.70
	16" o.c.	0.37
	24" o.c.	0.25
	32" o.c.	0.20
	40" o.c.	0.16
	48" o.c.	0.13
8" thick walls	All cells filled	1.04
	16" o.c.	0.56
	24" o.c.	0.36
	32" o.c.	0.28
	40" o.c.	0.23
	48" o.c.	0.19
10" thick walls	All cells filled	1.37
	16" o.c.	0.71
	24" o.c.	0.48
	32" o.c.	0.37
	40" o.c.	0.30
	48" o.c.	0.25
12" thick walls	All cells filled	1.62
	16" o.c.	0.83
	24" o.c.	0.55
	32" o.c.	0.43
	40" o.c.	0.35
	48" o.c.	0.29

Table shown for illustration only. Quantities will vary based a variety of project specific conditions such as number and size of bars per cell, wall and cell configuration, cell isolation technique, waste, etc





## Grouting Requirements

- Grout must have a minimum strength of 2000 psi @ 28 days.
- Grout used with high strength masonry units should have a minimum compressive strength about equal to or exceeding the unit strength and must meet or exceed the  $f'm$  of the wall. Check the specifications.
- Grout must be placed within 1½ hours after the introduction of water but this can be waived for transit-mixed grout that meets the specified slump.
- Inspections must be complete before grouting can begin.



## Preparing to Grout

- Confirm the grout type and strength ordered.
- Confirm slump (or slump flow for SCG) test.
- Conventional Grout prepared on site must be mechanically mixed for 5 minutes minimum.
- If re-tempered with water to adjust slump, (or slump flow for SCG) remix in mechanical mixer for 1 minute minimum.
- Transit mixed conventional grout should be slumped on site and remixed for 1 minute if water is added.





## Preparing to Grout

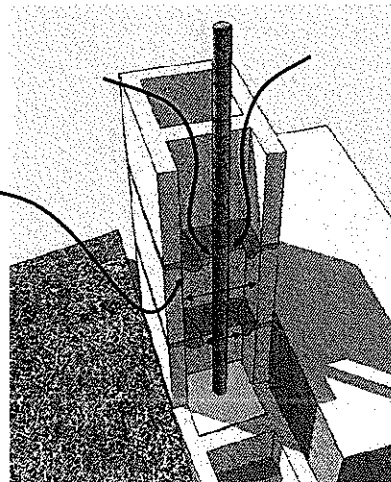
- Remove debris from grout cells and cleanouts. Rebar must be in place before grouting can begin.
- Inspect cleanouts before sealing them shut.
- Mortar must be sufficiently cured to ensure the integrity of the wall during the grouting process.
- Sufficient length of rebar must extend above the grout to ensure proper splicing.



## Mortar Fins (protrusions)

Mortar fins restrict the flow of grout into cells and can actually trap air.

They must be removed before grouting takes place. The best time to do this is during wall construction.





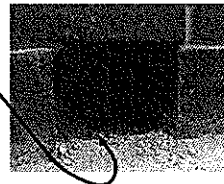


## Methods of dealing with Mortar Fins

Proper technique in the application of mortar and the setting of the CMU should minimize mortar fins.

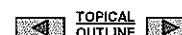


However, remaining fins should be broken free and dropped to the cleanouts and removed before grouting takes place.



## Choosing Between Coarse & Fine Grout

- Coarse grout is typically more economical than fine grout and is usually preferred.
- Both coarse and fine grout can be designed to achieve necessary strength requirements.
- Space consumed by mortar fins must be subtracted from the clear space.
- Minimum clear cross-sectional dimensions of the cells to be grouted are shown in Table 7 coming up shortly.





## Pour Heights vs. Lift Heights

- Grout pour heights, the total height of masonry wall to be grouted prior to the erection of additional masonry, are limited by grout type, fine or coarse, and the size of the grout cell.
- These limitations are shown in Table 7 Grout Space Requirements on the next slide.
- Grout lift options refer to heights to which grout can be placed in a single operation.
- One grout pour may have one or more lifts.

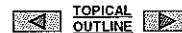


Table 7 -Grout space requirements \*

Grout type	Maximum grout pour height, Ft.	Minimum width of grout space, In.	Minimum grout space dimensions for grouting cells of hollow unit in. x in.
Fine	1	3/4	1 ½ x 2
Fine	5	2	2 x 3
Fine	12	2 1/2	2 ½ x 3
Fine	24	3	3 x 3
Coarse	1	1 ½	1 ½ x 3
Coarse	5	2	2 ½ x 3
Coarse	12	2 ½	3 x 3
Coarse	24	3	3 x 4

\* 2005, 2008, 2011 MSJC





## Low-Lift vs. High-Lift Grouting

- Low-lift grouting is typically restricted to 5' lifts (5'4" in 2011 MSJC) maximum.
- Low-lift grouting does not require cleanouts.
- Low-lift grouting potentially produces more cold joints and requires more individual grouting operations and lap splices.
- High-lift grouting requires a cleanout for each vertical rebar or spaced not more than 32" in fully grouted walls.
- Building codes do not use the terms 'low-lift' or 'high-lift' grouting.



## Grout Lifts

- Grout lifts are not to exceed 5' (5'-4" in 2011 MSJC) .
- However, lifts up to 12'-8" are permitted when certain conditions (as described on the next slide) are met.
- Permissible SCG lift heights may be even higher – up to the pour height when certain conditions are met.
- The table in the following slide indicates lift height options and requirements.

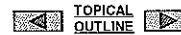




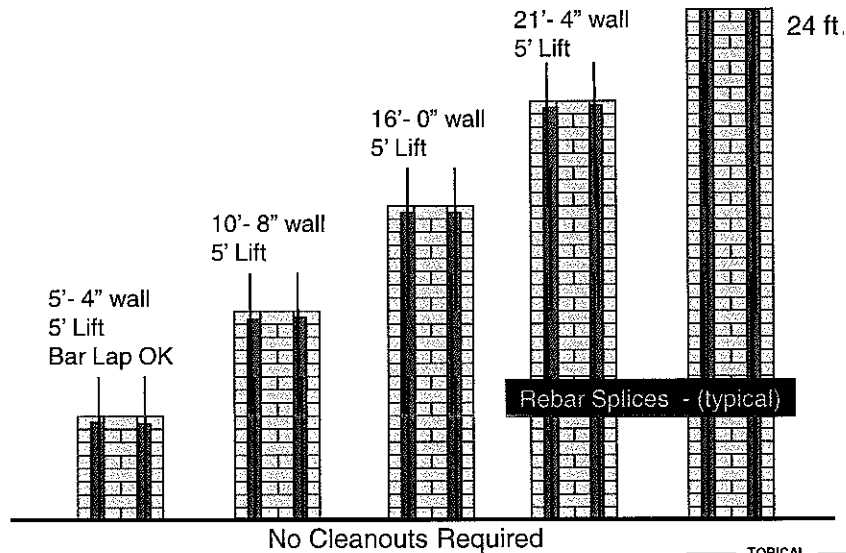
## Grout Lifts

Lift Heights	Requirements	Grout type
5'0" '08 MSJC 5'4" '11 MSJC	No clean outs required. do not exceed pour height in Table 7	Fine, coarse or SCG
5'0" (5'4") to 12'8"	Clean outs required , do not exceed pour height in Table 7, masonry cured at least 4 hrs, slump of 10" – 11", no reinforced bond beams between top and bottom of lift	Fine, coarse or SCG
12'8" to 24'	Clean outs required , lifts not to exceed pour height in Table 7 for masonry cured 4 hrs or more, otherwise lifts limited to 5' (5'4" 2011 MSJC)	SCG

Note: If approved by the engineer demonstration panels may be used to demonstrate alternate methods or options

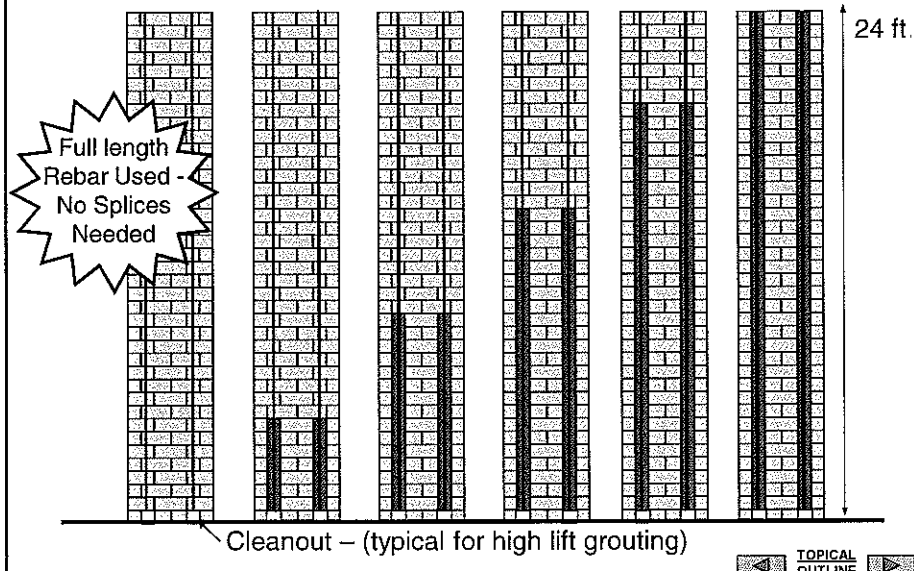


## Low-lift grouting to build a 24' wall in 5' lifts

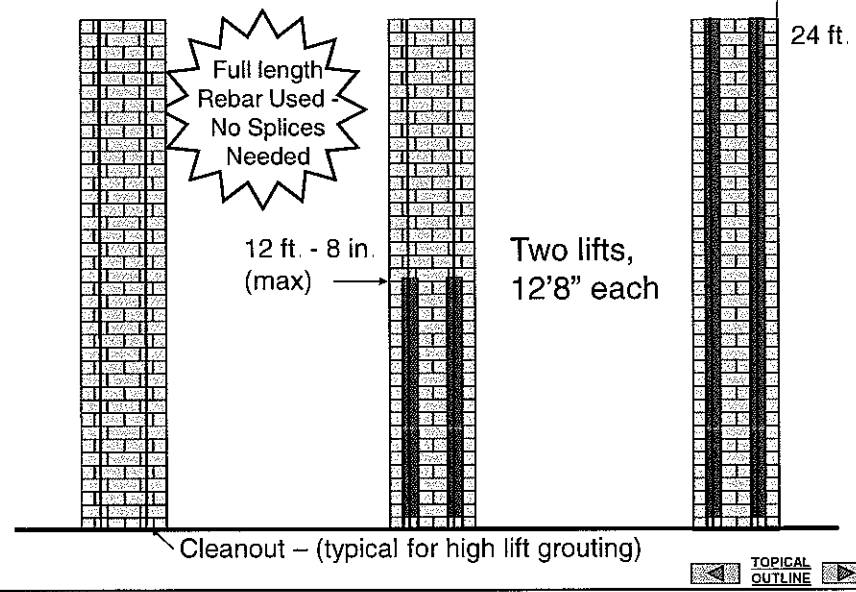




### High-lift grouting to build a 24' tall wall in 5' lifts

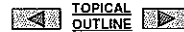
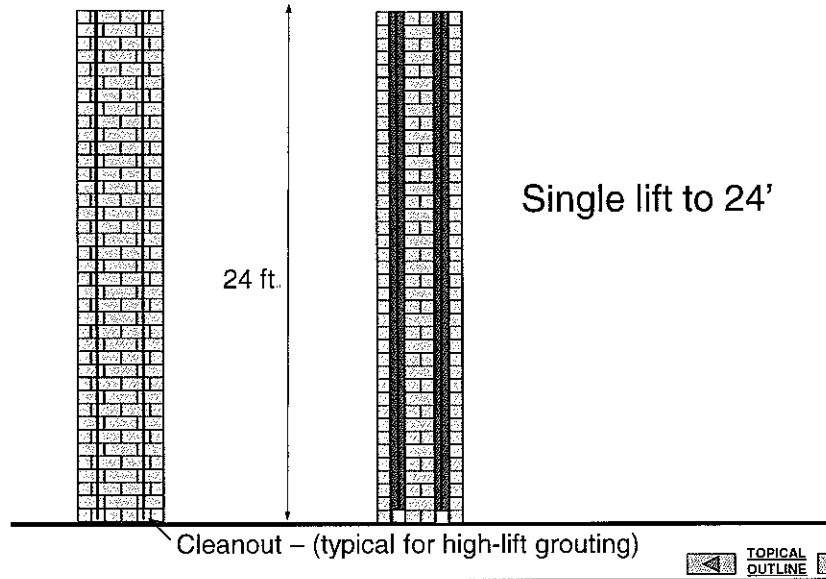


### High lift grouting to build a 24' in 12'-8" Lifts





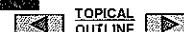
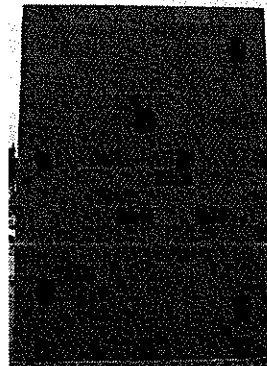
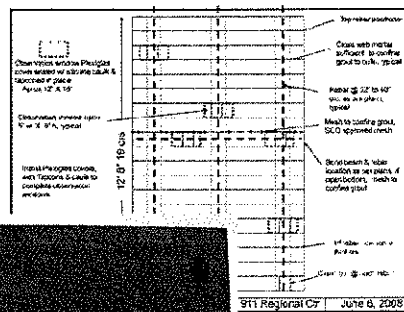
### High-Lift grouting to build a 24' wall using SCG



### Grout Demonstration Panel

Grout demonstration panels provide contractors a way to propose additional options or methods of reinforcing and grouting.

The panel shown here was used to gain approval to use SCG before it's use was more clearly stated in the 2008 MSJC & 2010 ASTM 476.





## Consolidation – Conventional Grout

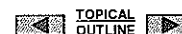
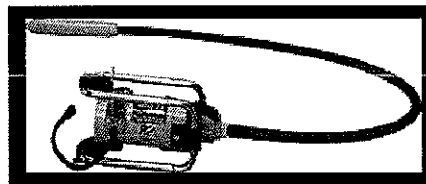
- Consolidation is required.
- Lifts of 12" or less can be puddled by hand
- Mechanical vibrators should be used for grout placements greater than 1'.
- Consolidation should occur immediately after grout is placed.
- Consolidation should be quick, only a few seconds, to avoid aggregate segregation and excess pressure on mortar joints.



## Consolidation – Conventional Grout

- Reconsolidation should occur after initial water absorption takes place, often within 10 to 15 minutes.
- Reconsolidation should never be done after one hour or if plasticity has been lost.
- Vibrator head should be  $\frac{3}{4}$  inch to 1" in size.

Portable electric vibrator with  $\frac{3}{4}$ " head.



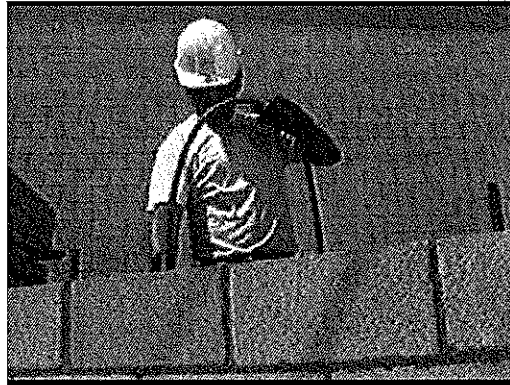


## Consolidation

Vibrator first pass

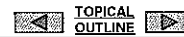
## Reconsolidation

Vibrator second pass



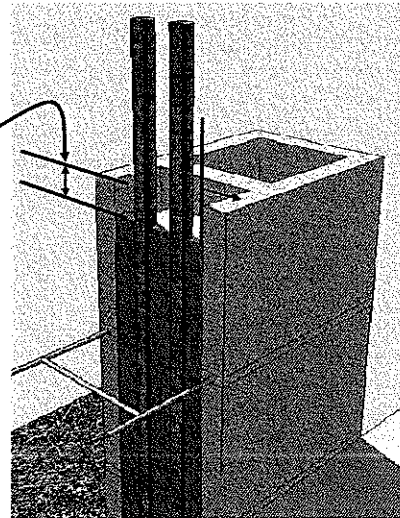
Conventional  
Grout

Click on picture to pause or animate.



## Grout Keys

Grout must be stopped at least 1" below the top of the block to avoid alignment of the mortar joint & the grout.

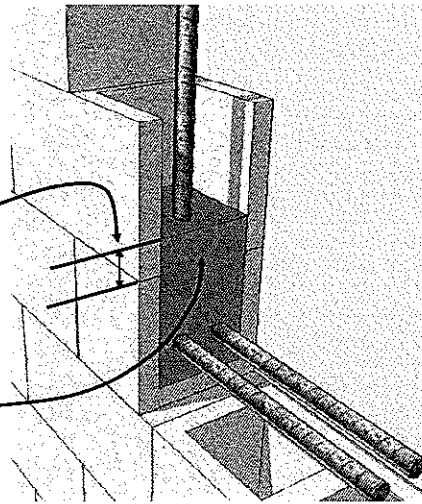






## Grout Keys

When grouting bond beams, grout must extend at least 1" into the next block to provide a full strength bond beam and to create a key.

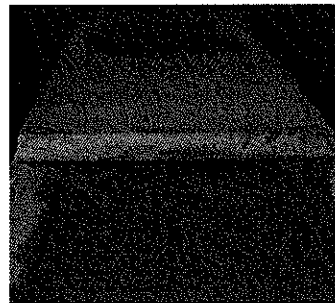


## Top of Wall Bond Beams

As water is absorbed into the CMU, the grout shrinks in volume.

Bearing plates require full bedding to avoid overloading the face shells of the CMU.

Grout should be topped off after the initial shrink occurs to ensure a solid bearing surface.





## Control Joints

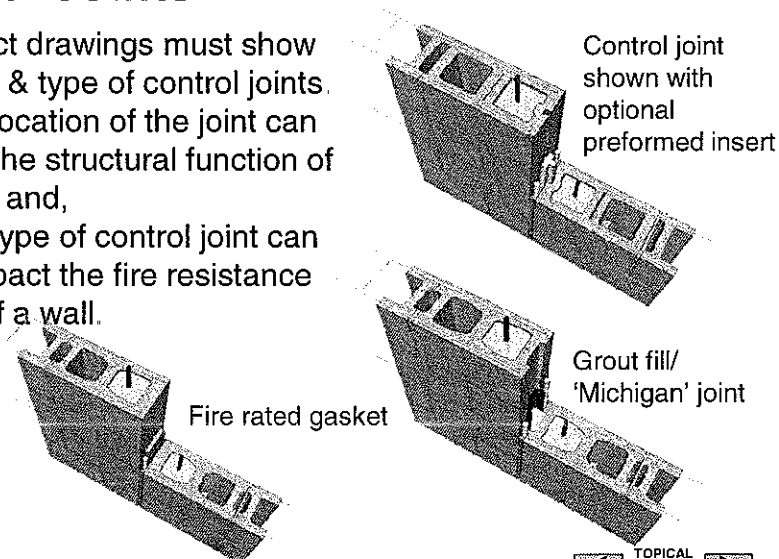
Concrete products shrink as they cure so control joints (CJs) are required to control shrinkage cracking.

- They are typically finished by inserting a backer rod and applying a sealant.
- Reinforcement is usually discontinuous at CJs or is placed to allow movement on one side, although there may some applications where it is continuous such as floor or roof diaphragms or bond beams.



## Control Joints

- Project drawings must show location & type of control joints.
- The location of the joint can impact the structural function of the wall and,
- The type of control joint can also impact the fire resistance rating of a wall.

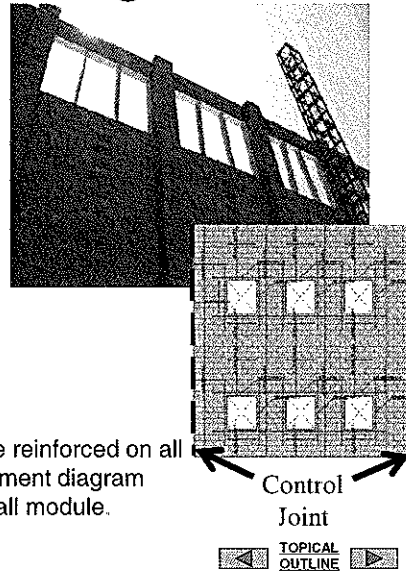




## Control Joints Off Opening

Placing control joints off the opening has some advantages:

- There are fewer control joints to deal with.
- By moving CJs off the openings engineers can take advantage of arching action to design more efficient lintels.



Using this method openings must be reinforced on all sides. This illustration is a reinforcement diagram from the RAM Elements masonry wall module.



## Inspection

Projects may have up to three types of inspection:

- Owners representatives will inspect for contract compliance.
- The permitting agency will inspect the structure to ensure compliance with applicable building codes
- Structural masonry is often required to be inspected by a Certified Masonry Special Inspector to ensure the building is constructed as required by the engineer.



## Inspection

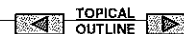
- Most buildings designed with structural masonry are engineered buildings. Engineered buildings, by code, typically require masonry special inspection.
- Special Inspection requirements must be detailed in the project documents as the level of inspection varies based on specific project criteria.
- In addition to code requirements, special inspection can be required:
  - If the structural engineer of record requires it.
  - If the owner or CM require it as a part of a quality assurance program.



## Inspection

Special inspection observations may be:

- Periodic - Typically at the beginning of construction and then intermittently throughout construction
- Continuous – Full time observation of work in progress in all areas where it is being performed.
- Special inspectors prepare on-going reports and end of project reports, and can stop work if a problem is serious enough.





## Inspection

Special inspection observations can include:

- Approval of submittals (like grout mixes)
- Mortar joint construction
- Grout space prior to grouting
- Construction & protection under cold or hot weather conditions
- Preparation of grout specimens & prism tests



## Inspection

Special inspection observations can include:

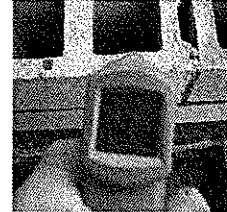
- Grade and size of rebar, ties & other reinforcement elements
- Location and installation of reinforcement & connectors
- Placement & consolidation of grout
- Special types of masonry construction such as: prestressed masonry, AAC, or welding of rebar





## Cold or Hot Weather Placement

- Requirements for masonry construction in both cold and hot weather conditions are addressed by the code.
- Key provisions of the code address:
  - Requirements during construction
  - Protection of placed masonry
  - Covers both mortar & grout requirements
- There are specific requirements for various temperature ranges. (See chart in next slides)



## Cold - Weather Provisions - Hot

40F to 32F	Between 40F & 100F or 90F w/wind	Greater than 100F or 90F w/wind to 115F or 105F w/wind
Below 32F to 25F		
Below 25F to 20F		
Below 20F		





## Cold - Weather Construction Provisions

40F to 32F	Heating of mortar materials is required but not for grout.	Greater than 100F or 90F w/wind to
Below 32F to 25F	Heat grout aggregates & water to produce grout between 70F & 120F grout must be above 70F when placed	115F or 95F w/wind
Below 25F to 20F	Plus: Heat masonry to 40F before placing grout	Greater than 115F or 105F w/wind
Below 20F	Plus: Provide enclosure & heat to maintain air above 32F	

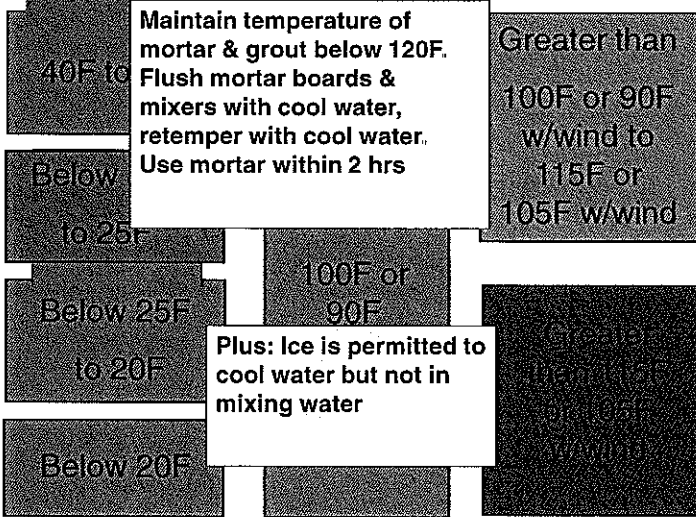


## Cold - Weather Protection Provisions

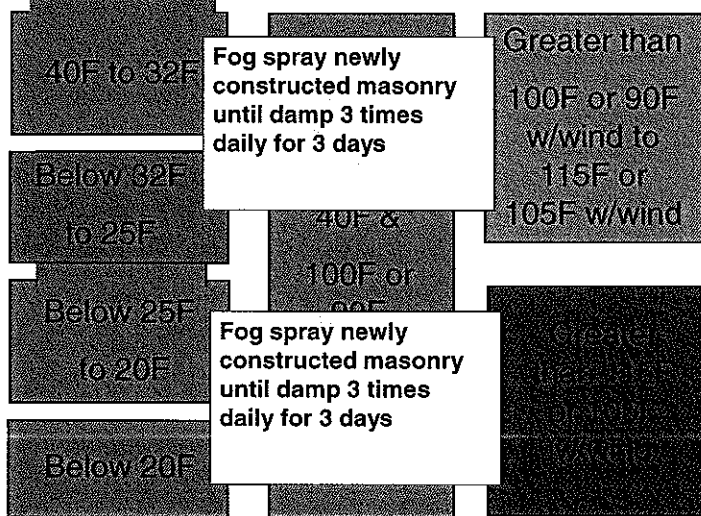
40F to 25F	Cover with weather resistive membrane for 24 hrs	Greater than 100F or 90F w/wind to 115F or 95F w/wind
Below 25F to 20F	Cover with weather resistive membrane for 24 hrs, 48 for grouted masonry unless Type III cement was used	Greater than 115F or 105F w/wind
Below 20F	Provide enclosure & heat to maintain air above 32F for 48 hrs, for grouted masonry unless Type III cement was used	



### Hot Weather Construction Provisions



### Hot Weather Protection Provisions





# Grouting & Reinforced Masonry Construction



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Professional Education Programs  
Version 06. 1.03  
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