Structural Masonry Design Tips

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Two good resources for structural masonry are Masonry Standards Joint Committee (MSJC) Code and Specifications, Building Code Requirements for Masonry Structures and Specification for Masonry Structures. Both are in the 2009 International Building Code. Several ASTM standards provide the general building blocks of structural masonry to help get started, but they are not applicable to all projects, nor all-inclusive. NOTE: These tips should not be used in lieu of professional knowledge and expertise.

TIP 1: Use the MSJC checklists
Both MSJC Code and Specification have often overlooked checklists: Mandatory Requirements and Optional Requirements. The Checklists and notes help specifiers choose alternatives or add provisions.

TIP 2: Start with the correct and most current standard
For structural concrete masonry buildings, for example, specify *ASTM C 90-09, Standard Specification for Load-bearing Concrete Masonry Units*, the 2009 edition.

TIP 3: Know that unit compressive strength is independent of unit density
Minimum compressive strength requirements in ASTM C 90 are the same for all density classifications. In other words, 'lightweight', medium-weight' and 'normal-weight' units must all meet the same compressive strength requirements.

TIP 4: Remember that ASTM C 90 includes minimum requirements
Table 2 of ASTM C 90 lists 'minimum requirements' but no maximum, which allows the engineer to specify higher strength units.

TIP 5: Consider specifying higher compressive strength
Economics, material efficiency, and the potential for thinner walls or less reinforcement mean that higher strength CMUs can be specified if available, with no cost premium. Project documents should reflect higher requirements; material test reports verify compliance.

TIP 6: Mortar type matters
Mortar affects masonry wall assemblies on a structural level. The cost difference between Type S and Type N mortars is pennies per square foot; the first one offers higher compressive strengths.

TIP 7: Watch what is specified for field QA for mortar
Both MSJC Code and Specification have often overlooked checklists: Mandatory Requirements and Optional Requirements. The Checklists and notes help specifiers choose alternatives or add provisions.

TIP 8: Get to know ASTM C 1586
ASTM C 1586, *Standard Guide for Quality Assurance of Mortars*, discusses proper use of ASTM C 270 and ASTM C 780 for mortars produced in the lab and at the construction site. It helps designers and users evaluate project needs for specifying and testing.

TIP 9: Specify grout strength appropriately
Grout and reinforcement enhance the structural capabilities and strength of masonry assemblies, allowing taller, thinner walls, and fitting high-wind and seismic zones. However, it takes careful detailing and proper construction practices. The minimum grout compressive strength permitted by the *MSJC Code and Specification, IBC*, and *ASTM C 476, Standard Specification for Grout for Masonry*, is 2000 psi. A good practice is to specify grout strength approximately equal to the unit strength to produce a structurally compatible wall.

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TIP 10: Understand grout pours and lifts
A grout lift is the amount of grout placed in a single, continuous operation. A grout pour is the entire height of masonry to be grouted before more courses are constructed. A grout pour can consist of one or more lifts placed in succession. Typically the contractor decides whether to use pours with clean-outs (i.e. often called 'high-lift grouting') or without them (i.e. 'low-lift grouting'). Grout pour height is limited by the *MSJC Code and Specification*, and is a function of the grout type (i.e. fine or coarse) and space dimensions. Grout lift heights up to 12 ft, 8 in. are permitted under specific conditions: masonry cured for at least four hours; grout slump of 10 to 11 in., and no intermediate horizontal reinforced bond beams between the top and bottom of the pour height.

TIP 11: Give the Contractor Some Latitude
Take advantage of contractor expertise in both technical considerations and constructability, when it comes to selection of fine or coarse grout, determination of pour and lift height, and use of self-consolidating grout.

TIP 12: New technology usually results in easier installation
One popular innovation in masonry construction is self-consolidating grout (SCG)—a highly fluid mixture of cement, water, fine and coarse aggregates, and plasticizing admixtures. Like conventional grout, it fills selected spaces in masonry walls and, after it hardens, to transfer loads to embedded reinforcement. While it can save time and labor, its impact on a project must be understand, along with the proper ASTM provision.

TIP 13: Green your grout with fly ash
Fly ash, the by-product of coal combustion, often supplements portland cement in masonry grout. ASTM C 476 permits the use of cement meeting ASTM C 595, *Standard Specification for Blended Hydraulic Cements* (15 to 40% by weight). Besides adding strength, it enhances the important grout properties of flow and pumpability. Its slower early compressive strength gain should be considered for cold weather..

TIP 14: Consider structural brick
The engineering requirements for structural brick masonry are included in *IBC and MSJC Code and Specification*. Steel reinforcement is placed either within cells of the brick units or within a grout space formed between two wythes of brick units. ASTM C 652-09, *Standard Specification for Hollow Brick*, offers options for units cored up to 60 percent. With steel reinforcement, any clay brick standard in the MSJC and IBC can be employed.

TIP 15: Consider AAC masonry
Autoclaved aerated concrete (AAC) masonry is a lightweight cellular concrete mix of lime, portland cement, aluminum powder, aggregate, and water, cut into lightweight blocks or panels. Easily cut onsite, it can be used for the structural support system in most areas, but check local requirements, plus *MSJC* and *IBC*.

TIP 16: Include lap splice length in project documents
Where issues of availability or constructability make it impractical to install a single continuous steel bar for the full length required, lap splicing provides the needed continuity. Designers must consult applicable requirements and show lap lengths and locations in the project documents. Contractors should not assume that responsibility.

TIP 17: Reduce lap splice lengths when necessary
Lap splice lengths are generally longer for larger diameter bars, assemblies with less cover, multiple bars in a cell, and lower-strength masonry units. Options to reduce lap splice lengths include smaller-diameter reinforcing bars spaced more closely together, using higher strength units, and minimizing splices with higher grout pours.

TIP 18: Consider other splicing options
MSJC and *IBC* also permit reinforcement spliced with mechanical couplers or welding. Mechanical couplers may be cost-effective over long lap lengths; welding of steel reinforcement is more difficult.

TIP 19: Think joint reinforcement, not bond beams
Both can be used to suit different needs. Joint reinforcement may be used to meet horizontal reinforcement requirements, while bond beams, a more expensive option, may offer more steel reinforcement area. For crack control, both may not be needed.

TIP 20: Consider Cleanout Options
There are multiple options for cleanout construction, which does not have to be a full face shell high. The minimum size is 3" and it can be concealed easily on interior walls with base molding.