MASONRY INSIGHTS

written in conjunction with International Masonry Institute

How to Specify Clay Structural Masonry f'm = 4000 psi in the Midwest

According to the masonry code, **TMS 602 Specification for Masonry Structures** (formerly MSJC), designers can use the Unit Strength Method for determining the masonry design strength, f'_m. The two components needed to use the Unit Strength Method are block strength and mortar type. A particular f'_m can be achieved by either: 1.) using stronger block and weaker mortar, or 2.) using weaker block and stronger mortar. Therefore simply stating a minimum f'_m on construction documents does not indicate to contractors what block or mortar should be used. Also, by only specifying f'_m, the required strength of grout is left unknown.

f'_m Net area compressive strength of concrete masonry	Type S Mortar	Type N Mortar
	f'_{cmu} Net area compressive strength of ASTM C90 CMU	
1,000 psi	1,700 psi	2,100 psi
1,500 psi	3,350 psi	4,150 psi
2,000 psi	4,950 psi	6,200 psi
2,500 psi	6,600 psi	8,250 psi
3,000 psi	**8,250 psi**	10,300 psi
3,500 psi	**9,900 psi**	----
4,000 psi	**11,500 psi**	----

Table 1 from TMS 602: UNIT STRENGTH METHOD TABLE
Compressive strength of masonry based on the compressive strength of clay masonry units and type of mortar used in construction (formatting revised for this paper)

The key components for the strength of clay masonry walls are the hollow structural clay units. Clay masonry units are available as either common/face brick or hollow brick. Hollow bricks are made to be able to add reinforcing. More information can be found at Brick Industry Association (BIA) gobrick.com under technical Note 41.

The common compressive strength in Midwest for hollow brick, f'_{brick} as determined by ASTM C652 tests, is 8,250 psi or higher. Higher strengths above 11,500 psi are also available from some manufacturers. See http://masonry.forsei.com/masonry/cmudata/ for strength data.

The next component that needs to be specified is the mortar. There is a lot of confusion over mortar strength and its effects on f'_m. The common mistake is to believe that masonry is only as good as its

weakest element - the mortar. It's important to remember that mortar only makes up a small percentage of the overall wall as most of the material in a wall is higher strength CMU. There is also confusion over testing; mortar tests are done in non-absorptive molds that result in a higher moisture content and less strength than mortar placed in a masonry wall between cured and dry CMU. Properties of mortar such as bond strength and workability are more important in many cases than compressive strength. TMS 602 clearly defines the strength of the wall to be more than the strength of the mortar. Mortar strength has been shown to be a relatively unimportant factor in determining f'_m. In TMS 602, Table 2 (section 1.4B.2.b) shows the type of mortar and unit strength can be used to find the assembly compressive strength, f'_m. TMS 602 also refers to the prism testing that was done (Figures SC-1 and SC-2) which supports the f'_m values shown in the table. Therefore it is also important to recognize that f'_m is dependent on the *type* of mortar, not the mortar *strength* – the requirements for the mortar strength are set once one selects the mortar type per ASTM C270 specification. *When specifying mortar, it is the mortar type (not mortar strength) that needs to be defined.* The two most common mortars to use in structures are Type S and Type N. Type S has benefits to strength and durability that make it ideal for walls that have structural load demands, such as bearing walls, exterior walls, shear walls, fire walls, stair shaft walls, elevator shaft walls, etc. **Type S is the common mortar type for structural** masonry walls. Type S is also good to use for walls below grade. Type N is also an option and preferred by contractors for non-structural masonry walls, such as masonry veneer walls and sometimes partition walls.

Following the recommendations above, designers should research available brick strengths and specify accordingly. For example, f'_{brick}=11500psi and Type S mortar for structural masonry. Using the **Unit Strength Method, the resulting f'_m will be 4,000 psi or higher;** see Table 2 on previous page.

Once f'_m is determined, the last concrete material to define when specifying masonry is grout. Grout compressive strength, f'_g must be defined. TMS code requires f'_g to be equal to, or exceed f'_m, but not less than 2000 psi. **When f'_m = 4000 psi, f'_g must be 4000 psi** or greater.

Therefore, simply indicating masonry strength, f'_m on the design documents is not enough for masonry. One needs to indicate the three components: 1. required block strength, 2. mortar type, and 3. grout strength. Below is an example of how to specify clay masonry material strengths in General Notes or Specifications.

MATERIAL NOTES FOR MASONRY	REQUIRED STRENGTH
HOLLOW BRICK, ASTM C-652	f'_{brick} = 11,500 PSI (MINIMUM) (NET AREA COMPRESSIVE STRENGTH)
MORTAR, ASTM C-270	TYPE S
GROUT, ASTM C-476	f'_g = 4,000 PSI (MINIMUM)
MASONRY ASSEMBLY	**f'_m = 4,000 PSI** **(NET AREA COMPRESSIVE STRENGTH)**

EXAMPLE SPECIFICATION