MASONRY INSIGHTS

written in conjunction with International Masonry Institute

How to Specify Concrete Masonry f'_m = 2500 psi in the state of Wisconsin

According to the masonry code, **TMS 602 Specification for Masonry Structures** (formerly MSJC), designers can use the Unit Strength Method for determining 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	
1,750 psi	---	2,000 psi
2,000 psi	2,000 psi	2,650 psi
2,250 psi	2,600 psi	3,400 psi
2,500 psi	**3,250 psi**	4,350 psi
2,750 psi	3,900 psi	----
3,000 psi	4,500 psi	----

Table 2 from TMS 602: UNIT STRENGTH METHOD TABLE

Compressive strength of masonry based on the compressive strength of CMU and type of mortar used in construction (formatting revised for this paper)

The key component for the strength of masonry walls is the blocks, commonly referred to as concrete masonry unit (CMU). CMU can be specified as normal weight, medium weight, or light weight. In Wisconsin, the most common CMU is Normal weight. However, both Medium weight and Light weight can also be specified and used. **The common compressive strength in Wisconsin for CMU, f'_{cmu} as determined by ASTM C90 tests, is 3,250 psi or higher.** Higher strengths can also be specified if desirable for a particular design, although cost and availability should be determined prior to specifying these higher values.
See http://masonry.forsei.com/masonry/cmudata/ for block 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 one needs to define.* 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 in Wisconsin 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, Wisconsin designers should specify f'_{cmu}=3250psi and Type S mortar for structural masonry. Using the **Unit Strength Method, the resulting f'_m will be 2500psi;** 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 = 2500 psi, f'_g must be 2500 psi** or greater. Some in the industry suggest using grout strength comparable to f'_{cmu}. The strength of grout is left to engineering judgment within the range between f'_m and f'_{cmu}. If specifying higher grout strength, note that the additional grout strength doesn't allow for a higher design strength (f'_m is still 2500 psi), however it may be desirable to have grout strength similar to block strength for better block/grout compatibility.

Therefore, simply indicating f'_m = 2500 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 masonry material strengths in General Notes or Specifications.

MATERIAL NOTES FOR MASONRY	REQUIRED STRENGTH
CMU, ASTM C 90	f'_{cmu} = 3250 PSI (MINIMUM) (NET AREA COMPRESSIVE STRENGTH)
MORTAR, ASTM C-270	TYPE S
GROUT, ASTM C-476	f'_g = 2500 PSI (MINIMUM)
MASONRY ASSEMBLY	**f'_m = 2500 PSI** **(NET AREA COMPRESSIVE STRENGTH)**

EXAMPLE SPECIFICATION