Concrete Masonry DESIGNS

JANUARY 2008

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RESIDENTIAL ISSUE

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A PUBLICATION OF THE

NATIONAL CONCRETE MASONRY ASSOCIATION

90th ANNIVERSARY

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Prevention of Efflorescence

What it efflorescence? - There are several white substances that could be on the masonry wall. But the most likely culprit is some form of water soluble salt. A simple, reliable taste test is a good way to check for the presence of salts.

Removing efflorescence - Most of these salt stains will naturally be washed away by rain-if the owner ill wait long enough. But since the staining usually occurs, it seems, the day before the Grand Opening, the natural reaction is to try to clean the masonry immediately. Since all lay people know that you use "muriatic acid to clean brick," the owner gets some and starts scrubbing-a big mistake. Little does he realize that the acid will cause a chemical reaction changing the salt to something that is no longer soluble and easy to fix. So what should be done? Relying on logic, one would expect that soluble salts could be dissolved by water. And that's pretty close to the solution. The correct approach is to dry brush the masonry surface to remove the majority of the crystallized salt on the masonry. Be aware that large amounts of water can reintroduce water back into the system, so measures should be taken to ensure that the water is clear, potable (drinkable), and salt free.

How did the salts get there? - It has often been stated that there are three components necessary to create efflorescence: soluble salts, water for dissolving the salt, and force for moving the solution to the wall surface. Eliminating any one of these components will most likely eliminate efflorescence on the masonry surface through some pathway, such as a crack in a mortar joint or masonry unit. In the spring, the catalyst for drawing the water to the surface is the warming of the air. Once the water reaches the masonry surface, it evaporates, leaving behind the salt-like material. The most common source of salt is the water used in mixing mortar or for cleaning masonry. That's why it's so important that the water used should be clean and potable, as is normally specified. Another common source of salts is the sand used in mortar. Sand should be washed with fresh water and stored off the ground to protect it from ground water, which sometimes has salts dissolved in it. Manufacturers of masonry units go to great extremes to minimize the salts present in their products. However, there are still some brick that may contain salt, however minimal.

How to aviod efflorescence? - Several precautions should be taken during construction to avoid efflorescence. To guard against contamination from ground water, store all materials off the ground. Brick and block should be stored under cover on pallets. Tops of walls should be covered at all times during construction to prevent unnecessary water build-up in the cavities. The use of silos or blended mortar material is a good way to protect sand, cement and lime on the job site.

Efflorescence in older buildings - In older buildings, the presence of efflorescence usually indicates a maintenance problem. Leaking roofs, faulty, guttering and downspouts, flashing failures, and even worn-out caulking can allow water to enter the wall system. Once repairs are made, the wall system should be allowed to dry before attempting to clean stains.

Other stains - In addition to efflorescence, there are a number of other stains that may show up on the face of wall systems. White scum is generally the residue of the cleaning process. If too little water is used during cleaning, the cleaner can evaporate before the mortar residue could occur if brick is not sufficiently saturated with water prior to cleaning. In this case, the cleaning solvent could be absorbed into the wall. Other stains, such as vanadium, manganese and lime run, can be cleaned with proprietary cleaners. But it's critical that the proper cleaner be matched with the condition to avoid worsening the situation. Also be aware that large amount of water are necessary to flush cleaning products and excess mortar from walls, and can reintroduce water back into the system. Once again, only use water that is clear, potable (drinkable) and salt free.

Summary - Although unsightly, efflorescence is a relatively harmless condition that usually will go away on its own. By taking steps to reduce the three contributing factors, the rate and severity of the condition can be reduced, providing the owner with a wall system that will deliver decades of reliable performance.

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Concrete Masonry DESIGNS

ON THE COVER:

Located in the heart of Tempe, Arizona's Millstone Townhomes features 48 three-story, attached homes constructed of concrete masonry units—80,000 to be exact.

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Millstone Townhomes are burning up the Tempe, Arizona real estate market. And it's no wonder; the units are built to resist fire, control sound and last a lifetime, thanks to concrete masonry.

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Concrete Masonry Designs magazine showcases the qualities and aesthetics of design and construction using concrete masonry.

Concrete Masonry Designs is devoted to design techniques using standard and architectural concrete masonry units, concrete brick, unit concrete pavers, segmental retaining walls, and other concrete masonry products around the world. We welcome your editorial comments, ideas, and submissions.

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Sustainability for Seattle Senior Services

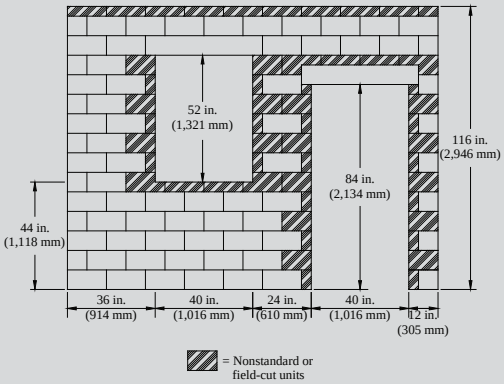
Located on Second Avenue in Seattle's Belltown neighborhood, the non-profit agency, Senior Services, is now headquartered in a new mixed use building that includes twenty-five condominium units for low-income housing in an attached tower. The structure is a 6,480-square-foot (602-square-meter), eight-story (plus a rooftop deck) concrete masonry frame building that was completed in February 2003.

NON-COMBUSTIBLE CONCRETE MASONRY ENABLED SENIOR SERVICES TO TAKE FULL ADVANTAGE OF THE 85 FOOT (24M) ALLOWABLE BUILDING HEIGHT.

MASONRY MODULAR CONSTRUCTION FOR GREATER ECONOMY AND SUSTAINABILITY

Not Recommended Construction:

Utilizing non-modular layouts or openings results in unnecessary cutting of the masonry units (shown here as shaded). The end product is more difficult to construct, produces more waste, and is more costly compared to a similar structure employing a modular layout. Additionally, placing and consolidating grout in the reduced-size cores of the field-cut units may prove difficult.

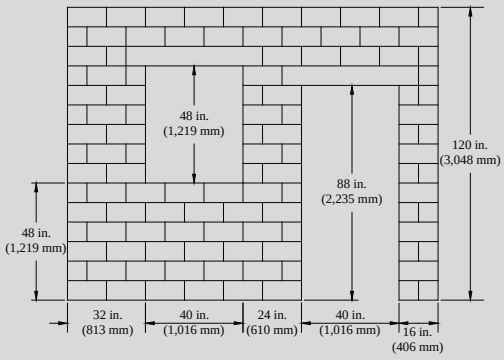


In this example, it is obvious the aesthetic impact non-modular layouts have on the final appearance of a structure. Not so obvious is the additional cost of construction. To further illustrate this concept, consider the following comparison of the modular and non-modular layouts shown here:

Total area of non-modular layout = 122.4 ft² (11.38 m²); 84.7 ft² (7.87 m²) net
Total area of modular layout = 126.7 ft² (11.77 m²); 88.9 ft² (8.26 m²) net
Number of units used in non-modular layout = 122
Number of units used in modular layout = 110

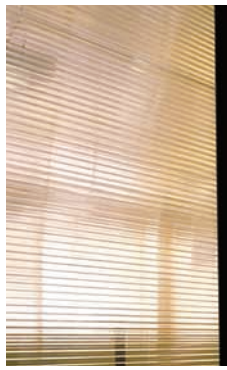
Recommended Construction:

The wall elevation shown here reduces the need to cut units by utilizing modular openings and opening locations (i.e., each dimension shown is evenly divisible by 8 in. (203 mm). By coordinating opening sizes and locations, the cells of hollow masonry units align (which facilitates the placement of vertical reinforcement and consolidation of grout), labor time is reduced and materials are not wasted, resulting in more sustainable construction.



For more information on modular layout of concrete masonry, see the detail of the month at the end of this publication and NCMA TEK 5-12 *Modular Layout of Concrete Masonry* available free on NCMA member web sites. Go to www.ncma.org for links.

On the ground floor, common-area amenities for office workers include large meeting rooms, multipurpose rooms, and interview rooms. According to Ed Weinstein, FAIA, Weinstein A|U Architects in Seattle, these meeting rooms were placed at street level to promote walk-in clients and pedestrian activity. The lower three floors take up the full dimension of the site and house the Senior Services' offices. The second and third floors contain Senior Services' program spaces, which are connected by an open stairway partitioned on one side by a glass wall. The building profile changes for floors four through eight to form the condo tower of residential units. This stepped area visually separates the office area in floors one to three from the condo tower that reaches eight stories high. On top of the office portion of the third floor is a landscaped terrace with a skylight for the offices below. On top of the condo tower is a shared rooftop terrace where residents can sit on benches that overlook the Pacific Ocean or enjoy small container gardens.

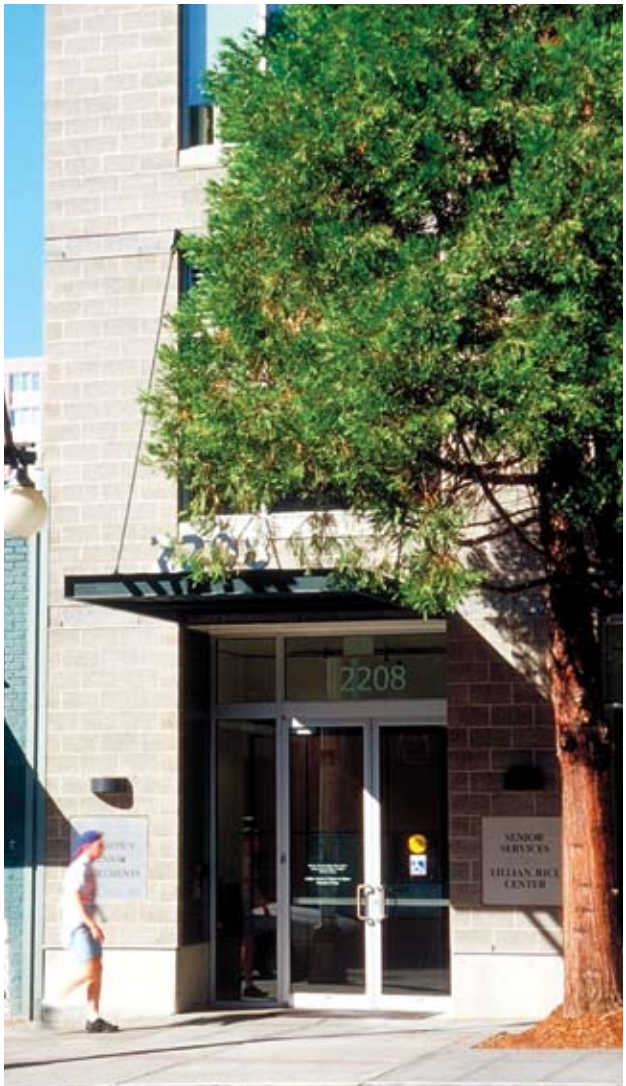


Project Goals

The goal of this project was to provide office space for the Senior Services agency, along with housing for low-income senior citizens. The structure needed to accommodate residential access 24 hours a day, seven days a week, while also maintaining security for the office when it was closed. Because the residential condo tower is not as deep as the office space on the first three floors, a skylight is provided on the roof of the third-floor office space. This lights an internal stair between floors two and three, bringing light into what would otherwise be a narrow, deep, dark building, when the office is closed.

Project Challenges

The budget for this project was tight—and so was construction space on the site, which is in the middle of a densely-developed block, flanked by the Senior Services agency on one side and senior housing apartments on the other, says Ed Weinstein, FAIA, Weinstein A|U Architects in Seattle. The area where Senior Services now stands is a very narrow site that is 59.5 feet (18 meters) wide by 106 feet (32 meters) deep. The structure was designed for seismic design



"We like CMU for its directness, meaning that it's a building material without many pretenses—and yet it is an essential building element... Of course using CMU also helps us meet budget on these projects."

—ED WEINSTEIN, FAIA, WEINSTEIN A|U

category (SDC) "D". The Washington State fire code for this type of structure requires a one-hour fire resistance rating between residential units.

"This site is located in the underdeveloped commercial district in Seattle that has a significant site envelope," says Weinstein. "With the pressure for redevelopment, we realized that adjacent structures would be built at a later date that would be equally as tall as ours. Our concern was to find a structural and cladding system that would look aesthetically pleasing in the short term, but would be an appropriate property-line wall once adjacent development began."

The area was zoned with an 85 foot (2626 meter) height limit because the existing neighbors are single-story structures. Concrete masonry was used on this project because the building height precluded the use of wood by code. When constructing bearing walls and veneer, concrete masonry offers more flexibility and economy than brick or other materials.

Design Components

The Senior Services building uses a cost-effective, unitized curtain wall and metal panel system that helped reduce construction time while allowing for large areas of glass for natural light to enter the office on the lower levels. "This was an aesthetic choice we made to treat the CMU walls as load-bearing and monolithic in the areas where we had significant windows," Weinstein comments. Metal window boxes below the windows provide scale and amenity to the residential floors.

The load bearing walls on the property lines were built using concrete masonry units. The walls at the short ends are built with CMU veneer. The office levels (the first three floors) were built with 12 x 8 x 16 inch (305 x 203 x 406 mm) CMU. The upper floors use 8 x 8 x 16 inch (203 x 208 x 406 mm) CMU. The stair/elevator penthouse at the roof was built with 6 by 8 by 8 inch (152 by 203 by 203 mm) CMU. The shear walls—the two stair shafts inside the building—are made of cast-in-place concrete with steel reinforcement that ties into the exterior CMU walls. "Nothing special was done for reinforcement detailing," says Weinstein, "other than making sure we maintained continuity where the construction changes from 12 inch (305 mm) to 8 inch (203 mm) units [on the fourth floor and up]."

An integral water repellent was used in the CMU, mortar and in the grout. The walls are all solid-grouted to protect against water penetration and to achieve fire ratings. An elastomeric coating was applied on the CMU walls in the stair well, elevator and penthouse areas. The floor system was built with 8 inch (203 mm) thick post-tensioned concrete slabs. These were tied into the CMU with steel reinforcement.

"We like CMU for its directness, meaning that it's a building material without many pretenses—and yet it is an essential building element," asserts Weinstein. "We felt CMU was an appropriate material for this project for both its economy and because we like it when juxtaposed with other materials [such as glass and aluminum windows] so it doesn't look too monolithic. Of course, using CMU also helps us meet our budget on these projects."

Visual Elements

No special-shaped CMU units, such as open-end (A- or H- shaped block), were used on this project, although the banding seen on the exterior of the building was accomplished by cutting the face shell off the block at the lower-floor levels and indenting the cut block face by 1/2 inch (13 mm) at each of the floor lines. The floor levels and slab thickness were coordinated so they worked out with the block module. These slightly darker bands of concrete masonry visually separate each floor of the structure.

The aluminum storefront windows were dimensioned to fit into the CMU, and the other windows are bracketed by CMU so that no cutting of the CMU was required. The windows extend up to the bottom of the floor slab for the level above. Structurally, this was achieved by using a steel angle set to align with the bottom of the slab and welded to an embed at the edge of the slab [see detail drawing].

Sustainable Design

In addition to offering a low-cost solution to senior housing, this project was built with sustainable design features in mind. It exceeds Seattle energy code requirements by 20 percent and received rebates from the Seattle City Light Built Smart program as well as significant annual energy savings for seniors and office users.

Project Awards

This project won the 2004 Seattle Times/AIA Housing, the Northwest Multi-Family Housing Tour and the 2004 Daily Journal of Commerce AIA Project of the Month awards. CMD

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ARIZONA'S

PROJECT
Millstone Townhomes, Tempe, Arizona

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GENERAL CONTRACTOR AND DEVELOPER
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MASONRY CONTRACTOR
Sidewinders Masonry, Queen Creek, Arizona

MASONRY SUPPLIER
Western Block Company, Phoenix, Arizona

STRUCTURAL ENGINEER:
Wright Engineers, Las Vegas, Nevada

SPECIAL THANKS TO THE ARIZONA MASONRY GUILD FOR ITS ASSISTANCE.

FOR WORK AND PLAY

With the holiday season passed and several months of snow-covered sidewalks, golf courses, and parks surely to follow in the northern United States and Canada, many yearn for the warm, sunny afternoons and comfortably cool nights of the Southwest. For decades, a most popular vacation spot has been Arizona for its resorts and spas—where an early-morning round of golf (on some of the best courses in the country), an afternoon of downtown shopping, and twilight jazz at a sidewalk café can be enjoyed in one location or within a few miles.

But vacationers don't have all the fun. Locals enjoy the same warm weather and outdoor activities year round—that is why they settled there in the first place. However, in recent years, Arizonans have raised the bar on their lifestyles. They want to live in an attractive, modern community where they can work and play without having to commute far to do either.

One such success is Millstone Townhomes in Tempe, a suburb of Phoenix, which was designed by Perlman Architects of Arizona Inc. in Scottsdale. Says Ken Powers, president of the firm and lead on the project, "We targeted the Millstone residential community for an opportunity to bring high-quality, beautiful housing to Greater Phoenix."

CONCRETE MASONRY ON ALL THREE FLOORS

Located in the heart of Tempe, Arizona's Millstone Townhomes features 48 three-story, attached homes constructed of concrete masonry units—80,000 to be exact. This means that all three floors in the seven buildings have concrete masonry for structural integrity, aesthetics, fire safety and sound insulation.

The townhomes are priced from the mid-$300,000s, with larger models—having three bedrooms, three baths and a two-car garage—from the low-$500,000s. Construction of the Millstone Townhomes in Maricopa County was completed in February of this year. At press time, the homes were nearly sold out, according to Jim Walton, co-owner of Barton Communities LLC, in Scottsdale, which was both developer and general contractor for the luxury home project.

'WELL-SITUATED, CLOSE-IN LOCATIONS'

Walton and his business partner, Patrick Barker, have run their small but busy firm since 1990 by consistently choosing "well-situated, close-in locations" for development, asserts Walton. Barton Communities was attracted to the Millstone Townhomes project because it is an easy walk to the picturesque and serene Arizona University campus.

"We compete for projects by using superior quality products and subcontractors," says Walton, the

partner who heads marketing and advertising for the firm, while Barker, the engineer-minded of the two, handles the technical side of the business.

A better building product, they both attest, is concrete masonry, because "it separates us from [those who build with] stick and stucco. When we look down the road 50 to 75 years, we want attractive, safe, and solid structures," confirms Walton. "Concrete masonry is much easier to maintain than other products, which is a huge plus for residents and owners. Concrete masonry is everlasting; it grows with the community."

Powers echoes the builders' attitude about concrete masonry, saying, "It conveys a sense of quality and permanence. Surface textures and colors can be easily accentuated to provide architectural interest to the project."

BEST FOR SOUND ATTENUATION AND FIRE PROTECTION

High development density drove the developers to build townhomes, rather than single family residences. However, in an upscale development like Millstone, residents may be willing to live side by side, but they aren't willing to listen to their neighbor's quarrels or TV shows. Similarly high sound attenuation through the exterior was paramount since the residences are "for sale" and situated in the Sky Harbor International Airport's flight path. Fully-grouted concrete masonry provides the ultimate sound barrier. Using solid-grouted 8 x 8 x 16 inch (203 x 203 x 406 mm) concrete masonry units easily achieves a sound transmission class (STC) rating over 50, compared to a little over 30 for a typical wood stud wall.

Simply put, STC describes how well a wall isolates sound from one area to another, with a higher STC providing superior noise insulation. The STC rating is correlated to decibels (dB) of sound reduction. Because decibels are a logarithmic, rather than linear, measurement, a difference in sound from 50 dB to 60 dB is perceived by the human ear to be twice as loud. Similarly, the noise passed through a wall with an STC of 40 can be considered to be twice the level transmitted through an STC 50 wall.

Concrete masonry STC values vary from about 43, for a wall constructed with hollow 4 inch (102 mm) units, to 63 for one of solid 12 inch (305 mm) units. In general, the STC rating of a wall varies according to the weight of the wall. For concrete masonry, the formula for determining the STC rating of a wall is: STC = 21.5 $W^{0.223}$ where W is the average wall weight in psf (SI: STC = 15.1 $W^{0.223}$ where W is in

"We pride ourselves on the concrete masonry we produce; our plant manager—Larry Johnson—has been with us since the first year we opened."

–TODD ALLSHOUSE, WESTERN BLOCK COMPANY, PHOENIX, ARIZONA

"Higher-density housing projects always put available site areas at a premium. Retention, guest parking, meaningful shared open space, site amenities, and strong street definition represent challenges for strong urban solutions."

–KEN POWERS, PERLMAN ARCHITECTS OF ARIZONA INC., SCOTTSDALE, ARIZONA

kg/m^2) (ref. NCMA TEK 13-1B). Therefore, grouted, sand-filled and solid concrete masonry units achieve higher STCs than do hollow units and higher density units also increase the sound-blocking ability.

The fully-grouted masonry walls not only provide superior sound insulation, they also far exceed typical minimum fire-safety requirements. Similar to STC, fire ratings provide an indication of the level of protection provided, with higher values offering better performance. Concrete masonry is widely specified for fire walls and fire separation walls because these elements are: noncombustible, provide durable fire resistance and are economical to construct. The basis for calculated fire resistance for concrete masonry assemblies is the "Code Requirements for Determining Fire Resistance of Concrete and Masonry Assemblies" (ACI 216.1-97/TMS 0216-97). This document is referenced and excerpted in the 2000-2006 Edition of the International Codes. A 2007 version has just been published and will be referenced in the 2009 I-Codes. (See the sidebar on the next page or NCMA TEK 7-1A for more information.) For the most part, the contents of the Standard are not new, but rather are a compilation and refinement of the many documents previously published by the various segments of the masonry and concrete industry. More importantly, the Standard is a document that has gone through a formal consensus process and is written in mandatory language, and therefore is now incorporated by reference into the national model codes.

Millstone was provided a minimum two-hour, fire-wall rating between units, achieved by using a solid-grouted 8 by 8 by 16 inch (203 by 203 by 406 mm) concrete masonry system. Note that this provided a fire rating of over four hours rather than the prescribed minimum two-hour rating. The system was employed for simplicity and sound attenuation as described above.

The recess around each of the windows was created with various widths of block. The windows were all modular, to minimize having to cut the masonry units and provide more economical construction. The project uses grouted and reinforced masonry lintel units over the openings. In masonry lintels as well as precast lintels, the fire rating is attained by providing a minimum amount of masonry cover over the reinforcing steel (see NCMA TEK 7-1A). These systems provide superior fire resistance to steel lintels as the steel lintels are on the exterior of the masonry and are not protected from the fire unless special protection is provided such as a spray on fireproofing material. The mansard and roof are standing-seam metal panel systems, which are all typical detailing for the area.

BETTER THAN STICK OR STUCCO ON FRAME

Western Block Company in Phoenix was the concrete masonry manufacturer for the townhome project, and provided interesting, multiple colors of smooth- and split-faced units. According to sales manager Todd Allshouse, the 36-year-old company's mission is three pronged—"performance, quality, and tradition. We pride ourselves on the concrete masonry we produce. Our plant manager, Larry Johnson, has been with us since the first year we opened."

When asked how a pro-concrete masonry builder responds to naysayers who say the product is too expensive, Walton replies, "True. It costs more to build—but we get it back in price and sales, especially for attached housing, like Millstone. We're not building for the moment; we want clients to look down the road 50 to 75 years and see a safe, strong, and attractive building still serving those it was intended to serve."

Although Tempe has only 40 square miles (104 km^2) and 170,000 residents, it is a major suburb of Phoenix (with 1.5 million residents) and is bordered by other larger Arizona communities—Chandler, Mesa and Scottsdale. As such, Tempe is widely considered the crossroads of southeast Arizona.

Downtown Tempe, where Millstone Townhomes holds some of the city's prime real estate, attracts upper-middle class couples and families to its 280-some shops and restaurants, and live music venues in parks and the streets of the Mill Avenue District. Vacationers are attracted to the same amenities and rent the luxury townhomes for a week or months at a time.

PROJECT 'WILDLY SUCCESSFUL'

Mimicking the design of successful "town centers" sprouting up across the nation, Tempe has a manmade lake providing a scenic view and strategically placed fountains to hush the bustle. The project was "wildly successful," comments Jim Walton, though he mentions a problem fitting 48 townhomes on fewer than two acres (0.8 ha)—"We had to build dense."

Ken Powers concurs with Walton about constructing in downtowns. "Higher-density housing projects always put available site areas at a premium. Stormwater retention, guest parking, meaningful shared open space, site amenities, and strong street definition represent challenges for strong urban solutions." But, concludes Walton, "It was a challenge, but one that was well worth the effort." CMD

CALCULATED FIRE RESISTANCE RATING OF CONCRETE MASONRY

Concrete masonry is widely specified for fire walls and fire separation walls because these elements are:

- noncombustible,
- provide durable fire resistance, and
- are economical to construct.

The fire resistance rating period of concrete masonry elements can be determined by three methods per the model building codes including the International Building Code:

- calculation,
- through a listing service, or
- by testing.

The calculation method is the most practical and most commonly used method of determining the fire resistance rating of concrete masonry. "Code Requirements for Determining Fire Resistance for Concrete and Masonry Construction Assemblies" (ACI 216.1/ TMS 026) is a national consensus standard which provides the basis for calculated fire resistance of concrete masonry in incorporated into the international codes. It is based on extensive research and results of previous testing of concrete masonry walls. Fire testing of wall assemblies is conducted in accordance with the Standard Test Methods for Fire Tests of Building Construction and Materials, ASTM E 119 which measures four performance criteria.

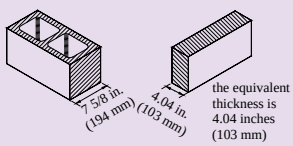
ASTM E 119 Performance Criteria:

- resistance to the transmission of heat through the wall assembly,
- resistance to the passage of hot gases through the wall sufficient to ignite cotton waste,
- load carrying capacity of load bearing walls, and
- resistance to the impact, erosion, and cooling effects of a hose stream on the assembly after exposure to the standard fire.

The fire resistance rating of concrete masonry is typically governed by the heat transmission criteria. This type of failure mode is certainly preferable to a structural collapse endpoint characteristic of many other building materials from the standpoint of life safety (particularly for fire fighters) and salvageability.

Extensive testing has established a relationship between the fire resistance and the equivalent solid thickness for concrete masonry walls as shown in Table 1. Equivalent thickness is essentially the solid thickness that would be obtained if the same amount of masonry contained in a hollow unit were recast without core holes. The equivalent thickness of a hollow unit is determined in accordance with Standard Methods of Sampling and Testing Concrete Masonry Units, ASTM C 140.

The equivalent thickness of a 100% solid unit or a solid grouted unit is equal to the actual thickness (solid grouted walls were used in the Millstone Townhomes). Additionally if the cells of hollow unit masonry are filled with approved materials, the equivalent thickness of the assembly can be considered the same as the actual thickness. The list of approved materials includes: sand, pea gravel, crushed stone, or slag that meets ASTM C 33 requirements; pumice, scoria, expanded shale, expanded clay, expanded slate, expanded slag, expanded flyash, or cinders that comply with ASTM C 331 or C 332, or perlite or vermiculite meeting the requirements of ASTM C 549 and C 516, respectively. For partially grouted walls where the unfilled cells are left empty, the equivalent thickness for fire resistance rating purposes is equal to that of an ungrouted unit.



For more information see NCMA TEK 7-1A *Fire Resistance of Concrete Masonry Assemblies* free on NCMA member web sites. Go to www.ncma.org for links to these sites.

TABLE 1–FIRE RESISTANCE RATING PERIOD OF CONCRETE MASONRY ASSEMBLIES

Aggregate type in the concrete masonry unit[2]	Minimum required equivalent thickness for fire resistance rating in inches (mm)[1]						
	4 hours	3 hours	2 hours	1.5 hours	1 hour	0.75 hour	0.5 hour
Calcareous or siliceous gravel	6.2 (157)	5.3 (135)	4.2 (107)	3.6 (91)	2.8 (71)	2.4 (61)	2.0 (51)
Limestone, cinders or slag	5.9 (150)	5.0 (127)	4.0 (102)	3.4 (86)	2.7 (69)	2.3 (58)	1.9 (48)
Expanded clay, shale or slate	5.1 (130)	4.4 (112)	3.6 (91)	3.3 (84)	2.6 (66)	2.2 (56)	1.8 (46)
Expanded slag or pumice	4.7 (119)	4.0 (102)	3.2 (81)	2.7 (69)	2.1 (53)	1.9 (48)	1.5 (38)

1. Fire resistance rating between the hourly fire resistance rating periods listed may be determined by linear interpolation based on the equivalent thickness value of the concrete masonry assembly.

2. Minimum required equivalent thickness corresponding to the hourly fire resistance rating for units made with a combination of aggregates shall be determined by linear interpolation based on the percent by volume of each aggregate used in the manufacture.

"Using concrete masonry helped us meet our fire ratings...we use concrete masonry because we are very sensitive to the importance of sound control."

–DAVID SOBOTA, PRINCIPAL ARCHITECT AIA, DTS + WINKELMAN

Grand Theatre Condominiums—Looking Good, Sounding Better

In Grand Haven, Michigan, the Grand Theatre Condominiums is a new five-story structure that provides modern, urban living just blocks from the waterfront and beaches of Lake Michigan. The first story is a street-level, gated parking garage, topped by four floors (20 residential units) of loft-style condominiums. On top is a 3,000-square-foot (279-square-meter) rooftop patio where residents can entertain or take in the views of the spectacular sunsets over Lake Michigan. Just outside the front lobby door, residents have access to diverse dining, boardwalk boutique shops and other entertainment on the waterfront.

THE GRAND THEATRE CONDOMINIUM BUILDING IS A NEW FIVE-STORY STRUCTURE MADE TO LOOK LIKE IT'S BEEN IN THE NEIGHBORHOOD FOR YEARS. THOUGHTFUL DESIGN HELPS THE GRAND THEATRE CONDOMINIUMS RETAIN THE HISTORIC FEEL OF THE ORIGINAL THEATRE AND FIT IN WITH THE OLDER STRUCTURES IN THIS AREA.

Condo floor plans

The 20 residential units come in three different two-bedroom floor plans, each with about 1,300 square feet (121 square meters) of living space. Each unit was built using modern, urban finishes. This includes hardwood floors, exposed brick walls, and granite surfaces along with ceramic, porcelain, and glass tile.

Beyond the lavish amenities, perhaps the thing that most distinguishes the Grand Theatre Condominiums is that the new building gets its character, name, and location from the original Grand Theatre, an 80-year-old landmark movie theater, which flourished in the late 1920s. Architect David Sobota, AIA, DTS + Winkelman in Grand Rapids, Michigan, says that the new Grand Theatre condos are designed to maintain the historic feel of the waterfront district. To maintain part of the historic theater, DTS + Winkelman kept the original theater marquee and entrance facing Washington Street. The only other part of the original theater that remains is the original lobby, which has now been transformed into The Grand Seafood and Oyster Bar, a 75-seat steak, seafood, sushi, and jazz restaurant.

CONTINUING EDUCATION AIA

PROJECT
Grand Theatre
Condominiums
Grand Haven, Michigan

OWNERS
Ross Pope and Steve Loftis
Grand Haven, Michigan

ARCHITECT
DTS + Winkelman
Grand Rapids, Michigan

STRUCTURAL ENGINEER
Engineered Structures, LLC
Hudsonville, Michigan

GENERAL CONTRACTOR
Redhawk Builders
Spring Lake, Michigan

NOISE CONTROL WITH CONCRETE MASONRY

Unwanted noise can be a major distraction, whether in the home or the work environment. Concrete masonry walls are often used for their ability to isolate and dissipate noise. Concrete masonry is an excellent noise control material in two ways. First, masonry walls effectively block sound transmission over a wide range of frequencies. Secondly, concrete masonry can effectively absorb noise thereby diminishing noise intensity. These abilities have led to the successful use of concrete masonry in applications ranging from party walls to hotel separation walls, and even highway sound walls.

Sound transmission class (STC) provides an estimate of the performance of a wall in certain common sound insulation applications.

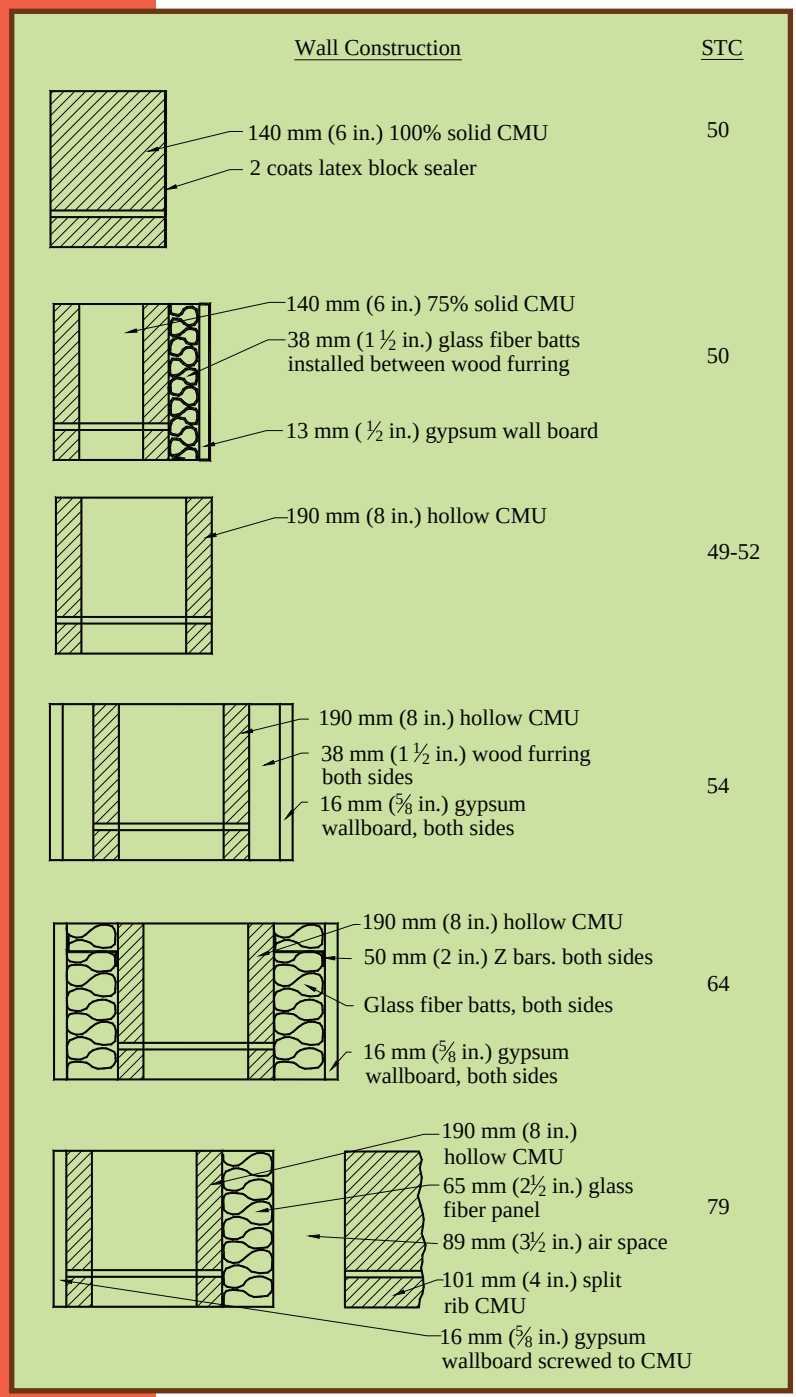
Many sound transmission loss tests have been performed on various concrete masonry walls. These tests have indicated a direct relationship between wall weight and the resulting sound transmission class—heavier concrete masonry walls have higher STC values. As shown in the adjacent figure, a wide variety of STC values is available with concrete masonry construction, depending on wall weight, wall construction, and finishes.

The International Building Code contains requirements to regulate sound transmission through interior partitions separating adjacent dwelling units and for those separating dwelling units from adjacent public areas, such as hallways, corridors, stairs or service areas. Partitions serving the above purposes must have a sound transmission class of at least 50 dB for airborne noise when tested in accordance with ASTM E 90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

In the absence of test data, standard calculation methods exist, although these tend to be conservative. Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls, TMS 0302 contains procedures for determining STC values of concrete masonry walls. According to the standard, STC can be determined by field or laboratory testing in accordance with standard test methods or by calculation. The calculation in TMS 0302 is based on a best-fit relationship between concrete masonry wall weight and STC based on a wide range of test results, as follows:

$STC = 21.5W^{0.223}$ [SI: $STC = 15.1W^{0.223}$] where W = the average wall weight based on the weight of the masonry units; the weight of mortar, grout and loose fill material in voids within the wall; and the weight of surface treatments (excluding drywall) and other components of the wall, psf (kg/m^2)

For more information see NCMA TEK 13-1B *Sound Transmission Class Ratings for Concrete Masonry Walls* and TEK 13-2A Noise Control with Concrete Masonry, available free on NCMA member web sites. Go to www.ncma.org for links.



Building structural walls with concrete masonry

The walls are load-bearing concrete masonry supporting precast hollowcore concrete floors. These structural walls were built with standard load-bearing concrete masonry units (CMU) with brick veneer as a facing. Sobota says that building the structure didn't pose many challenges other than the tight site constraints expected on a busy, urban street.

The exterior wall cladding was a burgundy blend of textural jumbo brick—about 9.6 inches (244 mm) long, with two per CMU course, instead of three—to bring warmth and human scale to the building. This was used on the interior structural walls as well. Custom tinted mortar was used to achieve an aged look.

"Using concrete masonry helped us meet fire ratings," Sobota comments. A two-hour fire rating was needed in the structure between the underground parking garage and the first floor. A one-hour fire rating was required between floors. "We are in a high-wind area, so using concrete masonry helped us with that component as well," says Sobota.

Minimizing sound transmission

In addition to high fire ratings and structural strength, concrete masonry provides superior sound insulation as well. The CMU and brick exterior walls have an STC rating of approximately 66, which works to block most of the noise from outside. On all the condo walls, Sobota used a double row of metal stud framing with sound batt insulation and 5/8 inch (16 mm) fire-rated gypsum board on each side with an additional layer of gypsum board in the middle, which creates an STC rating of 61. In comparison, consider that typical interior walls in many homes use two sheets of ½ inch (25 mm) drywall on a wood stud frame and have an STC of about 33, which offers very little in the way of privacy. Walls with STCs of 65 to 70 walls are typically only used for very luxurious multifamily units, high-end hotels, or for dedicated home theaters. Walls designed for well-built condo units typically strive for a STC of 50 to 60 in order to provide privacy from floor to floor and between units.

"We design a lot of condominium projects, and we use concrete masonry because we are very sensitive to the importance of sound control," states Sobota. "When savvy buyers look to purchase a condo, one of the first things they should ask is 'what is the separation wall made of, and what is the STC rating of the wall?'" According to Sobota, the average cost of a condo unit in this building is about $375,000. "A condo owner in that price range shouldn't have to complain about noisy neighbors," asserts Sobota.

Using articulation for visual interest

Every fourth course, the brick cladding on the exterior of the building was recessed to create the dentil at the cornice and windows. The brick is stack bond on each side of the windows. Above each window is soldier coursing, with arched eyebrows above the windows at alternating stories. Another row of soldier coursing at each story adds interest and helps visually divide the floors. The windowsill is made of rock-face stone. A spray-on liquid membrane waterproofing was used on the face of the CMU to repel water.

To complete the exterior walls, both smooth and rock-face stone were used on the first story and to accent the corners of the structure. The stone runs vertically the full height of the building with interval reveals on both south corners and above the first-floor lobby, stairwell and elevator shafts on the front northeast corner.

Retaining the historic feel

The exterior detailing helps the Grand Theatre Condominiums retain the historic feel of the original theatre and fit in with the older structures on this street. This project was the brainchild of two of the area's top businessmen, Ross Pope and Steve Loftis, who are co-owners of Grand Theatre Condominiums. According to Sobota, "My design marching orders from [Ross and Steve] were that they wanted this building to do two things: to look like it was built into the 1930s and to fit into the neighborhood. We didn't want the structure to look 'new'; we needed it to fit in as perfectly as if it had been there for years."

"Looking at the sketches and how the building turned out—there wasn't any fluctuation from the design sketches to the building itself. It's pretty amazing," says Sobota. "The owners weren't willing to compromise on their vision. They knew what they wanted, and they got what they wanted."

"We are delighted with how the new structure emulates the historic theater," says Ross Pope, co-owner of The Grand Theatre Condominiums. "It fits into downtown incredibly well, like it had been there since the early years of city." CMD

Concrete Masonry's AIA Continuing Education Learning Program

Learning Units Reporting form

To receive one learning unit, read "Sustainability for Seattle Senior Services" on page 4, "Arizona's Crossroads" on page 10 and Grand Theatre Condominiums—Looking Good, Sounding Better on page 14, and complete the questions on this page. Return this form to the National Concrete Masonry Association. Only original forms are accepted for learning unit credit.

Return forms before December 2008 to receive learning unit credits.

☐ I am a non-AIA architect or design professional. Please mail me a certificate stating that the learning units earned can be used to fulfill other continuing education requirements.

Send completed Report Form to: AIA CES, National Concrete Masonry Association, 13750 Sunrise Valley Drive, Herndon, VA 20171-4662. If you have questions, please contact NCMA at 703-713-1900.

January 2008

A I A Q U E S T I O N S (Circle the correct answer)

1. Higher Sound Transmission Class (STC) ratings indicate:
a. less noise transmitted through a wall
b. more noise transmitted through a wall
c. more noise reflected off the wall surface
d. A and C
e. all of the above

2. Solid grouting concrete masonry walls:
a. increases the STC rating of the wall
b. increases the fire rating of the wall
c. increases the water penetration resistance
d. all of the above

3. The Sound Transmission Class of concrete masonry walls increases with:
a. the weight of the concrete masonry
b. the addition of grout to all concrete masonry cores
c. the addition of plaster finishes
d. B and C
e. all of the above

4. Load bearing concrete masonry was chosen for the Seattle Senior Services Building because of its flexibility, economy, fire resistance, sound transmission resistance, and aesthetic appeal:
a. True
b. False

5. The calculated fire resistance rating of a concrete masonry wall is a function of:
a. the type(s) of aggregate used in the CMU
b. the equivalent thickness of the CMU
c. mortar type
d. A and B
e. all of the above

6. The STC ratings are logarithmic and therefore are perceived by the human ear as follows:
a. linearly
b. doubling the STC is perceived as twice as loud.
c. an increase of 10 dB STC is perceived as twice as loud.
d. doubling of the STC is perceived as 10% louder.

7. The fire resistance rating of a concrete masonry wall can be increased by:
a. filling all masonry cores with grout or an approved aggregate
b. filling some masonry cores with grout or an approved aggregate
c. adding an approved finish material
d. A and C
e. all of the above

8. The consensus standard adopted by the model building codes that provides the basis for calculated fire resistance of concrete masonry assemblies is:
a. Code Requirements for Determining Fire Resistance for Concrete and Masonry Construction Assemblies (ACI 216.1/TMS0216)
b. Building Code Requirements for Masonry Structures (ACI 530/ASCE 5/TMS 402)
c. Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS 602)
d. NCMA TEK 7-1A Fire Resistance Ratings of Concrete Masonry Assemblies

9. The formula for determining STC of concrete masonry is established by which consensus standard?
a. Building Code Requirements for Masonry Structures (ACI 530/ASCE 5/TMS 402)
b. Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS 602)
c. TMS 0302 Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls.
d. NCMA TEK 13-1B Sound Transmission Class Ratings for Concrete Masonry Walls

10. The calculated method of determining STC ratings:
a. supersedes any tested wall section
b. generally conservative and should only be used when actual test data is not available.
c. based on a detailed analysis of actual tests and are easier to use.
d. B and C above.

11. According to Table 1, a concrete masonry wall constructed using fully grouted 8 inch (203 mm) CMU (i.e., equivalent thickness = 7 $^{5}/_{8}$ inches (193 mm)), manufactured of limestone, cinders or slag has a calculated fire resistance rating of:
a. 2 hours
b. 3 hours
c. 4 hours
d. over 4 hours

12. Modular coordination on concrete masonry construction provides:
a. increased economy by reducing the need to cut masonry units to fit
b. less construction waste
c. for the use of standard-sized CMU
d. all of the above

AIA Member Information:

NAME

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CITY STATE/PROVINCE POSTAL CODE

PHONE FAX

E-MAIL ID NUMBER

I certify that the above information is true and accurate to the best of my knowledge. I have complied with the AIA Continuing Education Guidelines.

SIGNATURE DATE

☐ Check here to request a catalog of concrete masonry technical literature.

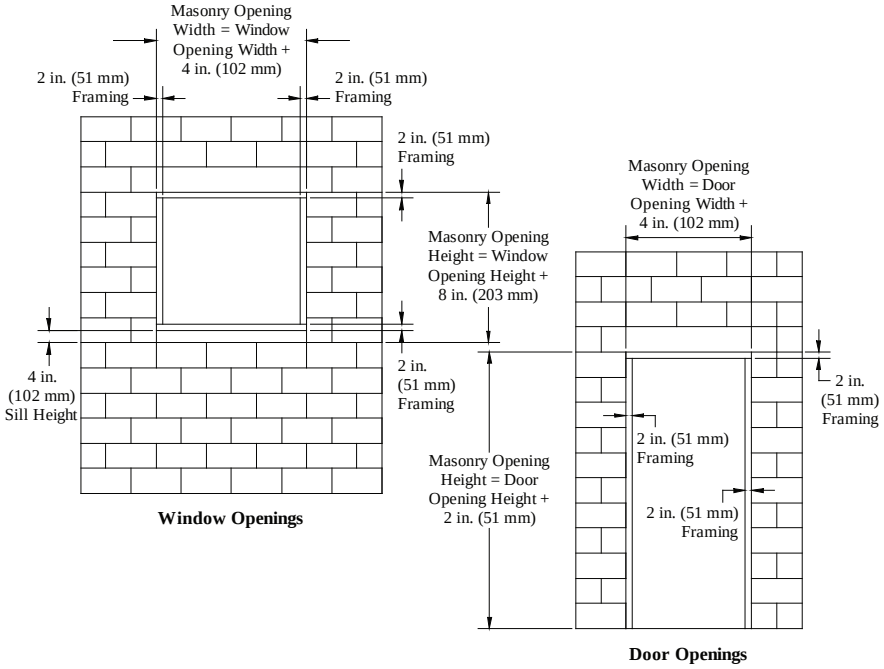
Modular Openings for Concrete Masonry Construction

Although concrete masonry structures can be constructed using virtually any layout dimension, for maximum construction efficiency and economy, concrete masonry elements should be designed and constructed with modular coordination in mind. Modular coordination is the practice of laying out and dimensioning structures and elements to standard lengths and heights to accommodate modular-sized building materials. When modular coordination is not considered during the design phase, jobsite decisions must be made–often in haste and at a cost.

For conventional construction methods, the widths of masonry openings for doors and windows should generally be 4 in. (102 mm) larger than the door or window width. This allows for 2 in. (51 mm) on each side of the opening for framing. Thus, door and window widths of 28, 36, 44 and 52 inches (771, 914, 1118 and 1321 mm) and so on in 8 inch (203 mm) increments do not require the masonry to be cut.

The heights of masonry openings to accommodate windows are typically 8 in. (203 mm) greater than the window height. This opening size allows for 2 in. (51 mm) above and below for framing and 4 in. (102 mm) for installation of a sill at the bottom of the window. Masonry openings for doors are commonly either 2 or 4 in. (51 or 102 mm) greater than the door height, allowing for the door framing as well as the use of a standard-sized door. For the commonly available 84 in. (2,134 mm) high door, a 4 in. (102 mm) door buck can be placed at the top of the opening. In addition, precast lintels are available in some areas containing a 2 in. (51 mm) notch to accommodate 80 in. (2,032 mm) doors.

Hollow metal frames for doors should be ordered and delivered for the masonry before the other door frames in the project are scheduled for delivery. For economy, the frames should be set before the walls are built. If the walls are built before the frames are set, additional costs are incurred to set special knock-down door frames and attachments. For more information, see NCMA TEK 5-12 *Modular Layout of Concrete Masonry* available free on NCMA member web sites. Go to www.ncma.org for links.



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WWW.MCMA.NET

The Minnesota Concrete Masonry Association's new website is a resource for industry professionals, architects, engineers, students, teachers, builders, contractors and homeowners. MCMA.net offers a variety of resources on technical issues, a calendar of events for the masonry industry, information for students, AIA HSW credit opportunities for architects and much more. MCMA.net is being updated constantly to provide the information you need. The website provides links to NCMA's Tek notes and other industry websites. If you cannot find what you are looking for please contact the MCMA office for additional assistance. We are open to suggestions in order to make this site as resourceful as we can.

MINNESOTA CONCRETE MASONRY ASSOCIATION

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