Shahnaz Jaffari, AIA Associate, LEED AP©
PhD Candidate, University of Colorado Boulder
Director of Sustainability, Rocky Mountain Masonry Institute

Building Green
Block by Block
March 2010

Concrete Masonry in Green Buildings: *Award winning Architects' Perspective*

Photo Courtesy of: Cooperthwaite Photography

NATIONAL CONCRETE MASONRY ASSOCIATION
Sustainable Concrete Products for Structures and Hardscapes
13750 Sunrise Valley Drive
Herndon, VA 20171-4662
Phone: 703.713.1900
www.ncma.org

Rocky Mountain MASONRY INSTITUTE
Rocky Mountain Masonry Institute
686 Mariposa Street
Denver, CO 80204
303-893-3838
www.rmmi.org

Acknowledgements

This work would not have been possible without the support and contribution of National Concrete Masonry Association (NCMA) Foundation and The Rocky Mountain Masonry Institute (RMMI) Board of Directors. I would like to thank Erik Absalon for putting forward the proposal and Robert Thomas for his help in developing survey questions and for sharing his vast knowledge and expertise with me. David Minor has helped orchestrate the survey efforts and his volunteer work is appreciated. Thanks to Diane Travis who reviewed the study and offered her technical assistance. My gratitude also goes to Nancy Partridge who edited the text for fluency and grammar. Tina Alberico was my partner in gathering the data and compiling them for this study and her extra effort is acknowledged. In addition I would like to offer my gratitude on behalf of NCMA and RMMI to the following building experts for their share in this study:

Marna Abrams, LEED AP, Associate, Marketing
Michael Bartunek, AIA, LEED AP
Daniel Bernstein, AIA, LEED AP
Johnny Birkinbine, AIA
Corky Bradley, AIA, LEED AP
Jonah Busick, LEED AP, Director
John Dick, AIA
Lance O'Donnell, AIA
Michael Elmore, AIA, LEED AP
Rick Espana
Ruth Fajarit- Davis, AIA, LEED AP
Steven J. Gloyeske, AIA, LEEDAP
Allen H. Kachel, AIA, LEED AP
Gregory Mella, AIA, LEED AP
Paul Mickelberg,AIA, LEED AP
Paul J. Pessetti, AIA, LEED AP
Jennifer Radicella, LEED AP
Mike Rhodes, AIA
Wyatt Rhodes
Daniel Safarik, Director of Marketing
Kevin Shibata
Jim Staniec, LEED AP
Heather Taylor, AIA, LEED AP
Laura Westphal, CPSM, LEED AP

Shahnaz Jaffari

Table of Contents

Abstract

Have you wondered what a “green” building material is? Has it been hard to choose materials for your green project?

During the past decade owners, developers, designers, and contractors have been faced with the challenge of choosing the right building materials for their green projects. It has been hard to prove or disprove industry claims on the newly developed or improved products called “green.” While bamboo flooring can substitute for tile and stone floors, experts have wondered if that choice is wise. Some have questioned the import of bamboo flooring from China while others have wondered about its performance and service life.

To make the choice of green materials easier for stakeholders, experiences need to be shared across the building industry. In this study 24 building experts who had used concrete masonry in their green projects were interviewed. Survey results proved that design teams chose concrete masonry for its inherent green attributes, some of which have not been recognized by LEED and other rating systems. The preferred qualities that have been overlooked include durability and long service life, aesthetics, minimal maintenance, reduced cost, thermal mass, impact resistance, fire resistance, noise reduction, and resource efficiency.

Cesar Chavez Library was chosen as one of the Top Ten Green Projects of 2008 by AIA Committee on the Environment and received the Valley Forward Association Crescordia Award for Environmental Excellence. Johnny Birkinbine, the architect for Cesar Chavez Library said:

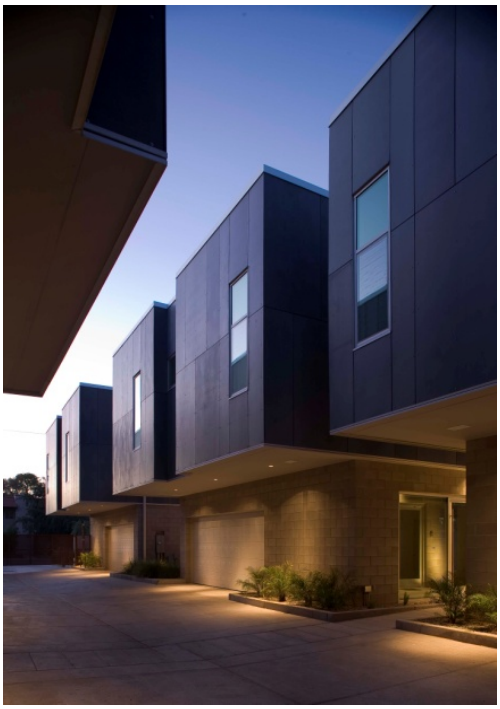
“Predating LEED or “green” projects, our office was founded in 1978 based on the creation of environmentally sensitive architecture. We have used concrete masonry as a primary building material in nearly all our projects since the firm’s inception.”

Is something missing in our material selection criteria?

The Green building movement has gained momentum within the past decade. Building industry stakeholders are considering market-driven green strategies, and green codes and standards adopted by various jurisdictions at an unprecedented rate. New green guidelines, standards, and codes are being developed using "lessons learned" in the application of Leadership in Energy and Environmental Design (LEED) and other rating systems. United States Green Building Council (USGBC) is trying to harmonize and synchronize its many rating standards; in LEED 2009 LEED credits are weighted according to their impact on the environment. The International Code Council (ICC) has collaborated with American Institute of Architects (AIA) and American Standards for Testing Materials (ASTM) to develop the first International Green Construction Code (IGCC). Green rating system developers are seeking a practical means of applying Life Cycle Assessment and passive strategies in their new versions.

Committees developing new versions of green standards and codes have come to realize that major concepts missing in earlier versions of rating systems need to be addressed. Many architects who have designed green projects have called LEED a first step in the right direction and have tried to go above and beyond the identified credits. They often refer to passive strategies as the easiest and cheapest concepts in design and construction of buildings that have been overlooked. Proper building orientation for example could save up to 30% in energy at no additional cost. All it takes is some attention at the programming phase and the design stage. Another effective passive strategy is to conserve energy with the use of mass walls and proper detailing.

Durability and long service life of buildings have also been overlooked in most green standards. Some architects designing with LEED criteria have had to use an "Innovation in Design" credit for durability of masonry in their project. There is no doubt that longer lasting buildings will help save virgin materials and reduce construction waste. Some argue however, that buildings may not be used for the same purpose over the course of a century. While this is a valid point, architects could consider functional flexibility in interior building design to ensure future adaptive reuse.



Project Name: The Galleries at Turney
Location: Phoenix, AZ
Architects: Merz Project
Website: www.merzproject.com
Photo Courtesy of: Matt Winquist
Awards and Certifications:
LEED-H, Certified
Eco-Structures "Evergreen" award 2008
Valley Forward Environmental Excellence Award 2007
AIA Arizona Sustainable Award 2007
Southwest Contractor, Best Private Green Project 2007

Many beautiful old buildings today serve a different purpose than their design intent a hundred years ago. In fact, adaptive reuse and historic preservation have not only saved buildings from demolition, they have preserved cultural heritage. Historic buildings in Europe and older cities in the United States take us back through history and provide a connection to our ancestors. Some ancient sites in the Middle East substitute architecture, inscriptions and stone reliefs for history books. In designing green buildings architects should focus not only on the design service life of buildings but also on the historic context of the site and the surrounding architecture.

Moreover, in the existing green standards more emphasis has been placed on recycled content than durability and resource efficiency. In defining environmental preferences it may be more logical to start with reducing consumption of virgin resources than recycling them. The next step would be to use building materials that are resource efficient. This can be achieved through two important methods. First is to reduce waste generated at the job site; a significant percent of waste generated in the United States comes from construction debris. Some building materials such as drywall have proven to be the least resource efficient. This may be due to the fact that drywall comes in large sheets, which produce scrap when cut to size. Masonry however comes in small modular units, and generates the least amount of waste.

The second step toward conserving resources is to choose resource efficient materials. Production efficiency of some building materials, such as metals, range from 5% to 30%. After extracted ore is used in metal production, the remaining 70% to 95% goes to landfill. For example, if a design team specifies a metal product that is 25% resource efficient, for every one ton of that product used in a building four tons of ore must be excavated from the ground. Masonry products are the most resource-efficient building materials. Concrete masonry manufacturers use more than 95% of the extracted material in their production.

Recycled content has been one the most important concepts utilized in controlling resource depletion. It is common sense to use resources as long as possible in as many cycles as feasible. One needs to be cautious however to look at the whole picture with a deeper vision. In the order of importance, recycling should follow durability and resource efficiency of building materials. Green building standards should compare the huge carbon footprint of recycling to the strategy of using less virgin material in the first place.

Recycling some building materials such as steel is energy intensive. In addition to remanufacturing, collecting steel waste and transferring it to the recycling plants consumes energy. Some steel waste is transported to China for recycling, and the reproduced material is transported back to the United States. In this process energy consumption and air pollution resulting from transportation and waste collection should be calculated and added to that of remanufacturing.

Recycling downgrades materials. In most cases, the recycled material is lower in quality than the virgin one. Downgrading can limit recycling to the extent that some products can only be recycled once or twice before the product is unusable. Building products that can be indefinitely recycled should therefore be classified as “greener” material. While gypsum products cannot be recycled, concrete masonry is indefinitely recyclable.

Project Name: Fire Central
Location: Tucson, AZ
Architect: WSM Architects
Website: www.wsmarch.com
Photo Courtesy of: Cooperthwaite Photography
Awards and Certification: Pending LEED Gold

While development of existing rating systems can be considered a first step toward designing green buildings a deeper vision is needed in their future revisions. Major concepts such as passive heating, cooling and lighting, durability and service life, resource efficiency, and recyclability need to enter green codes and standards. These and other environmental considerations will then help define material selection for buildings that will become our signature for the future generations. Buildings that will be beautiful, last a long time, and function well will be cultural heritage for future generations.

The Present Study

Many studies have been based on energy performance of existing green projects. Other research has been done on their cost, market value, rate of investment, occupant satisfaction and the like. There is however a lack of research on building materials and their performance in these projects. Studies should be done on how existing green measures affect material choice in new

construction, and how these selection criteria have helped achieve green building objectives. Design teams could benefit from clear information to guide future decisions.

In this report an analysis of interviews with 24 green building experts is presented. In these interviews, member of design teams have been asked to evaluate how concrete satisfied their sustainability objectives, and how properly LEED addressed these green qualities. The intent is to learn from the experience of these experts in using Concrete Masonry Units (CMU), also called Concrete Block, Segmental Retaining Walls (SRW), and Concrete Pavers. The question is whether the sustainable qualities of concrete masonry have had a part in its popularity over time. And if so, are the existing rating systems giving it sufficient credit for its green attributes.

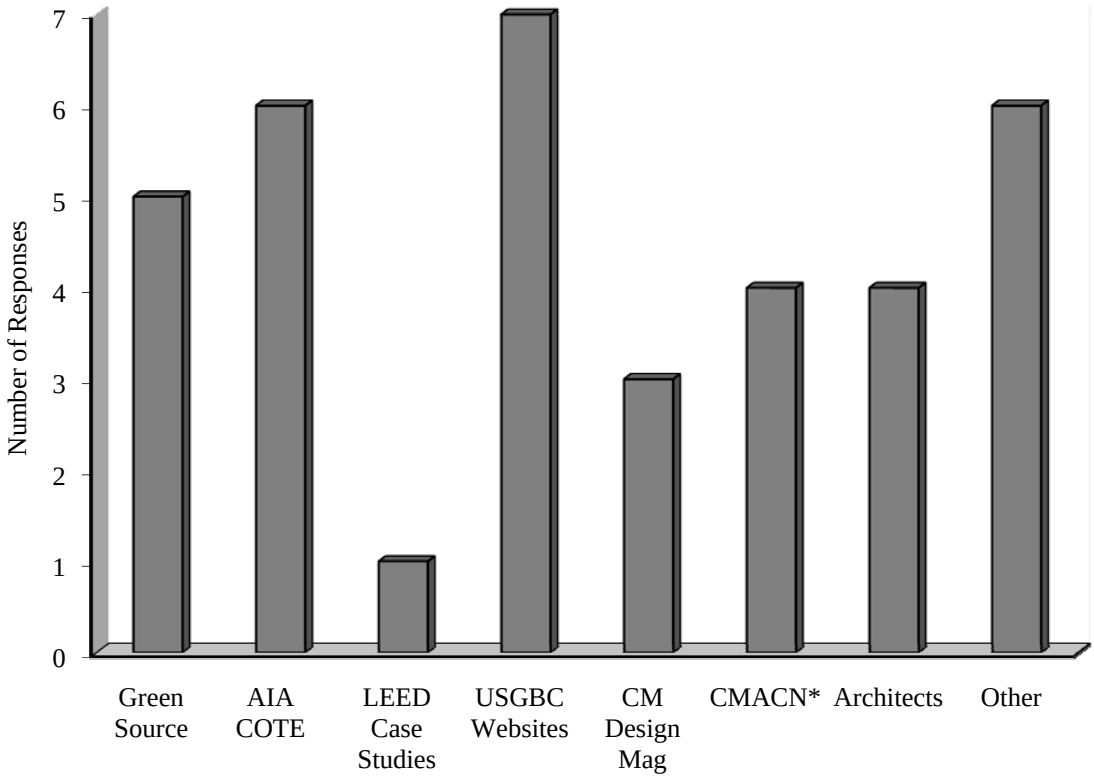
The interviews showed that architects picked concrete masonry for its inherent green attributes. Furthermore, the lack of LEED credits for some of its green qualities did not stop design teams from choosing it. For example, when asked if they received LEED credits for recycled content respondents gave 33% positive answers. Outside of LEED criteria however, 87% said they considered durability, and 65% considered beauty and minimal maintenance of concrete masonry. This result reveals that even though achieving LEED points is important for the designers, they have used their best judgment in selecting the material for its green qualities. Johnny Birkinbine, AIA, from Line and Space, Inc. explains his selection of concrete masonry:

> "The Cesar Chavez library focuses on making recycling and resource conservation its goal. In Phoenix, concrete masonry is relatively inexpensive, readily available and an environmentally sensitive material. Masonry's low transportation costs, intrinsic quality of thermal mass, natural fire-resistance, long life, flexibility, and low maintenance costs make it an environmentally sensitive material, allowing the design concepts to be achieved."

Methodology

A search was conducted to find existing study reports on building products and their role in the design and construction of green buildings. Attempts failed to find published surveys on this topic. It was surprising that no study was found that focused on masonry or any other building

materials in green buildings. Although the hope was to base this study on previous published papers, the research showed that this survey needed to start from scratch.



*CMACN: Concrete Masonry Association of California and Nevada

Figure 1: Sources of research and number of projects found

For this survey all apparent sources of information needed to be exhausted. As shown in figure 1 the best available resources seemed to be green rating systems websites, building industry websites and publications, and architects.

Some masonry green projects appeared in USGBC national and local sites, various masonry associations at local and national levels, and industry publications. Most of the sites did not have any information on building materials. Also most of the case studies focused on information about energy conservation and other LEED credits. To find projects that had used concrete masonry on the mentioned websites we had to basically look at pictures offered. This type of

search limited our sample to the buildings where concrete masonry was used on the outside of the buildings. The hope is to follow with another study from within the industry to find projects where concrete masonry has been used as load bearing and interior finishing materials.

Among the projects there were a few that had been designed as green buildings but had not applied for LEED or other green certification. These projects would complement the data sample not limiting it to LEED projects. The intention was to look at any available green building that had used concrete masonry and not to be biased toward any one rating system. In order to avoid any skewed results, effort was put in to equally searching the sites for all building types in different regions of the country.

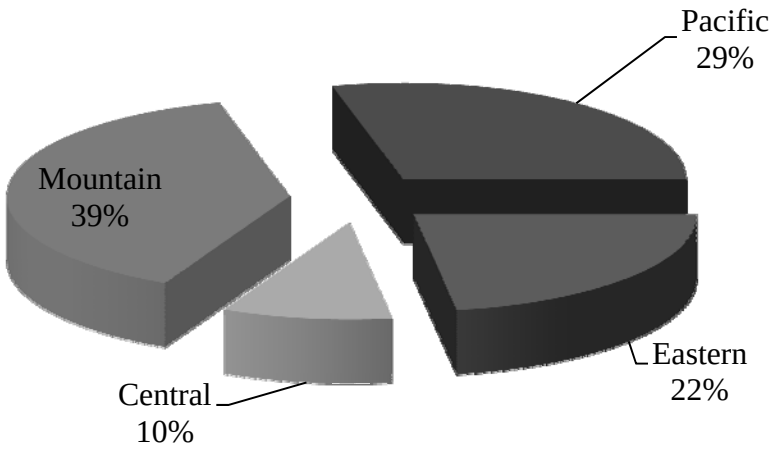


Figure 2: Location of green projects with concrete masonry in this survey

The second step was to find contact information for the person in charge of the green project and interview them. For better results the building experts were called before sending the survey questionnaire by e-mail. They learned through the phone calls about the intent of the survey before receiving the interview questions. One interview question asked that building experts list any other concrete masonry green buildings their firm had worked on. The search was stopped when 75 green projects with concrete masonry were located. From the total surveys sent out, 31 responses were received which made for about 45% return rate which is considered a good outcome for a survey of this type.

Before defining interview questions, some thought was given to the possible direction of the survey. There were two choices: One was to focus on the existing rating systems and what they considered "green attributes," and the other was to go beyond that and base the study on a combination of LEED credits plus items that were not recognized by LEED. Focus on "lessons learned" and analysis of "what has worked" and "what has been missing" could lead to better results. If this study was to become a base for further studies on building materials and their role in green building development, it needed to go beyond LEED, and other rating systems. In other words the focus needed to be on a wider horizon than boundaries set by existing established standards. Therefore emphasis was placed on LEED credits as well as passive design, building service life, aesthetics, fire safety, noise reduction, minimum maintenance, resource efficiency, and mold and VOC prevention through the choice of building materials.

Project Name: 2299 N. Via Monte Vista
Location: Palm Springs, CA
Architects: o2 Architecture
Website: www.o2arch.com
Photo Courtesy of: Korab Radoni
Awards and Certifications:
Home was certified Platinum in May '09
CMACN Sustainable Design Award
AIAIC Honor Award

Analysis

The first part of the interview focused on general information, such as firm, the interviewee, their position, project name, and project location. Responses to the first set of interviews showed that some questions should have been combined. However, for the sake of consistency, interview questions were kept the same during the entire survey process.

This report will give a summary of responses to each interview question in an attempt to offer the reader a comprehensive view of the survey. The reader can find more information about each project from their websites mentioned in Appendix A. Whenever permission has been granted, a photo of the project is included. In the same Appendix information is provided on LEED rating levels and awards achieved for these green projects.

Question 1: What sustainable awards and/or LEED certification have you achieved for the building?

Of green projects with concrete masonry, 17 were LEED buildings (Table 1). These included two LEED certified, four silver, six gold and three rated platinum. Eighteen of the 31 projects had received AIA awards including a sustainable design award. Seven buildings won energy awards including the AIA Energy Efficiency Integration Award. Projects also received five masonry awards and 36 other awards.

Project Type		LEED		AIA COTE Top 10	AIA Award	NCMA Award	CMACN	Other Masonry Awards	Energy Awards	Other Awards
Housing/ Residential		Platinum	1	1	8		1			8
		Gold	1							
		LEED-H Certified	1							
Schools	Elementary			1	3					7
	Middle	Pending Gold	1							
	High	Silver	1							1
	Higher Education	Gold	1	1	4	1		1	2	5
		Silver	1							
Hospital/ Medical Center		Silver	1		1			1		1
Library		Gold	1	1						1
		Pending Silver	1							
Environmental or Visitor Center		Platinum	2	2	1	1	1	1	3	12
Fire Station/ Training		Gold	1							
		Certified	1							
		Pending Gold	2							
Office		Pending Gold	1		1		2		2	1

Table 1: LEED Certifications and awards achieved for concrete masonry green project

Question 2: How long has it been since the building was completed?

The projects in this study were completed between 2002 and 2010. The buildings ranged in age up to 8 years. Green building is a fairly recent phenomenon, and future surveys are yet to perform a long-term evaluation of green building products. This kind of survey needs to be repeated as these buildings age while post-occupancy evaluations need to be performed at regular intervals.

Question 3: What is the occupancy classification of the building?

The intent of the question was to identify projects in as many categories as possible. The research showed that concrete masonry was used in a variety of building types including single family residence, multi-family affordable housing, libraries, office buildings, educational facilities, and a multi-use assembly building.

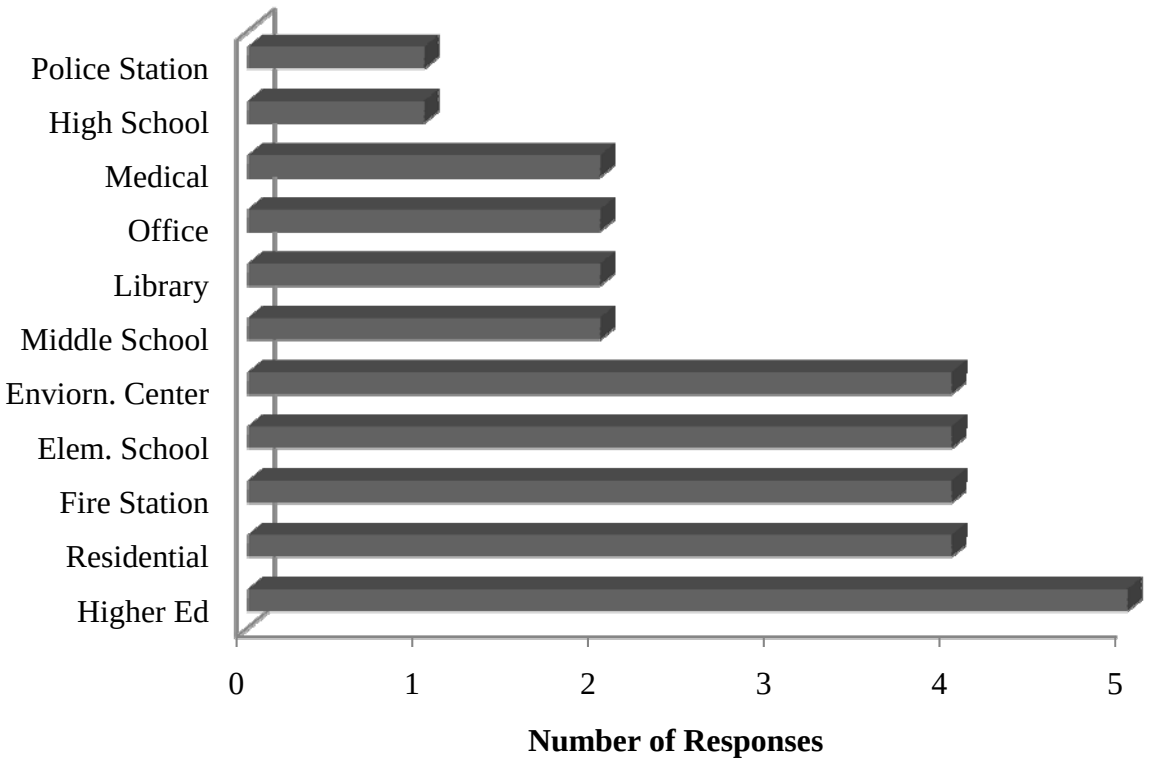


Figure 3: Building types of the surveyed projects

Question 4: Where in the project have you used concrete masonry (Concrete blocks, Segmental Retaining Walls, and Concrete Pavers)?

Most of the concrete masonry in the surveyed projects was used on the exterior skin of buildings, followed by interior use. As explained in the methodology section this may have been partially based on the sources chosen for this study. Since some projects were found from pictures, more projects were found that had used concrete masonry on the exterior. Other studies with other sources may show higher percentages for load-bearing and interior finishes than found in this research.

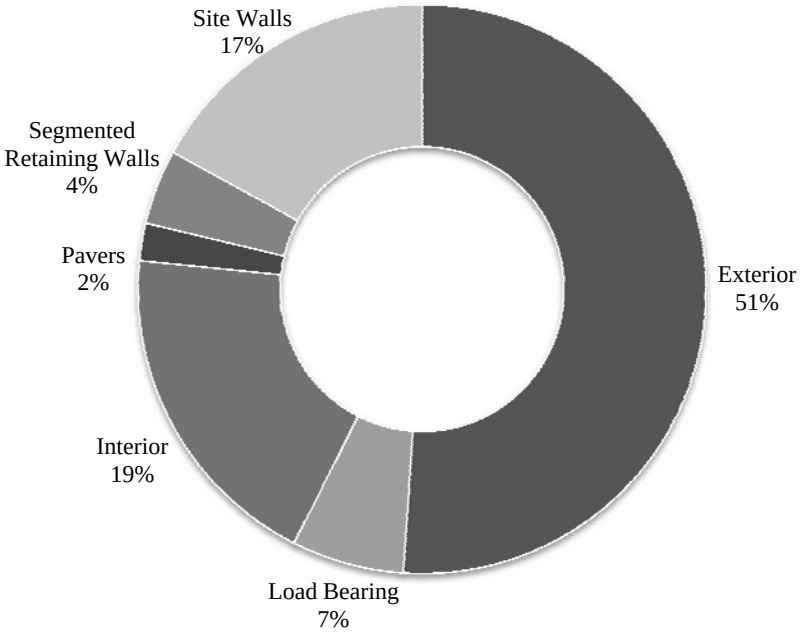


Figure 4: Concrete masonry placement in the projects

Question 5: What percentage of the total building is concrete block or SRW?

As shown in Figure 5, the green buildings in this survey used anywhere between less than 10% to more than 90% concrete masonry. This wide range is an advantage in selecting the data population, demonstrating differing proportions used in conjunction with other building materials.

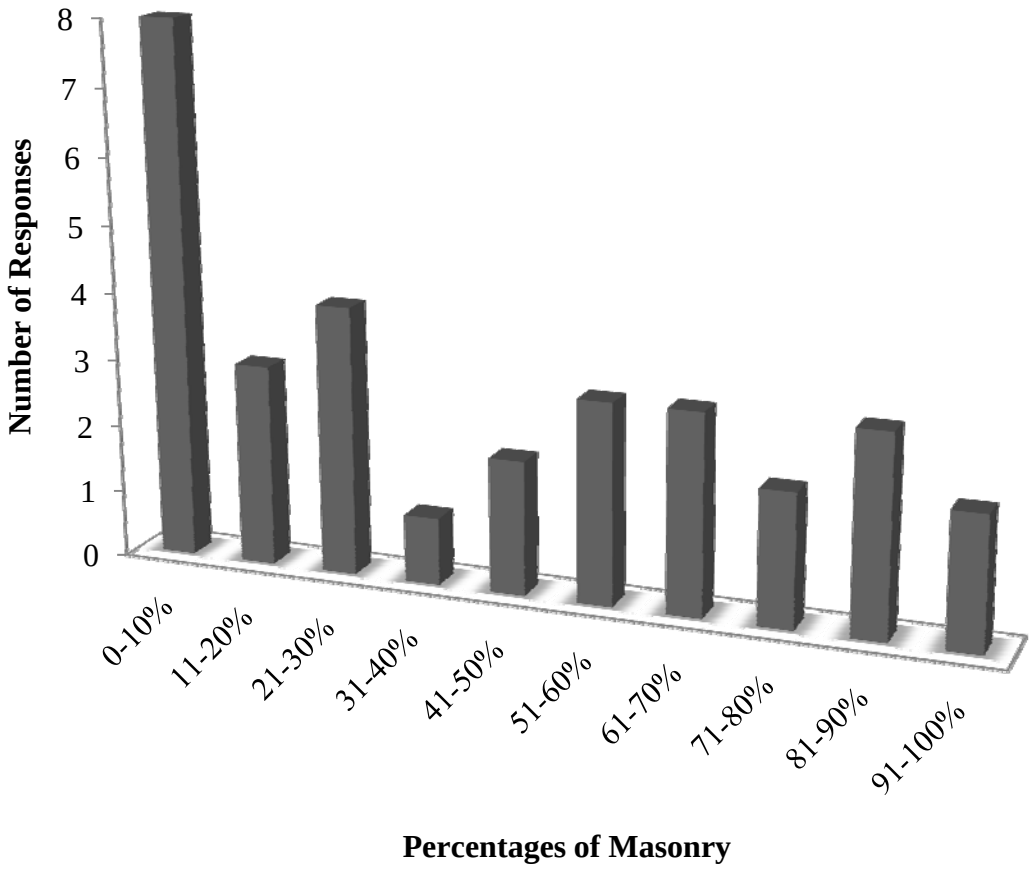


Figure 5: Percentage of concrete masonry used in the surveyed green buildings

Question 6: What percentage of the hardscape is made of concrete pavers?

Only two projects used concrete masonry as the hardscape. Perhaps water conservation in landscaping is not as popular yet. In new versions of green codes and standards more emphasis will be placed on reducing water use for irrigation, which may increase the use of concrete pavers.

Question 7: Which of the following "green" attributes of concrete masonry did you consider when choosing the material?

This question asked building experts to pick their favorite from a list of concrete masonry qualities. The responses showed that interviewed designers used concrete masonry regardless of the lack of LEED points for some of its green attributes.

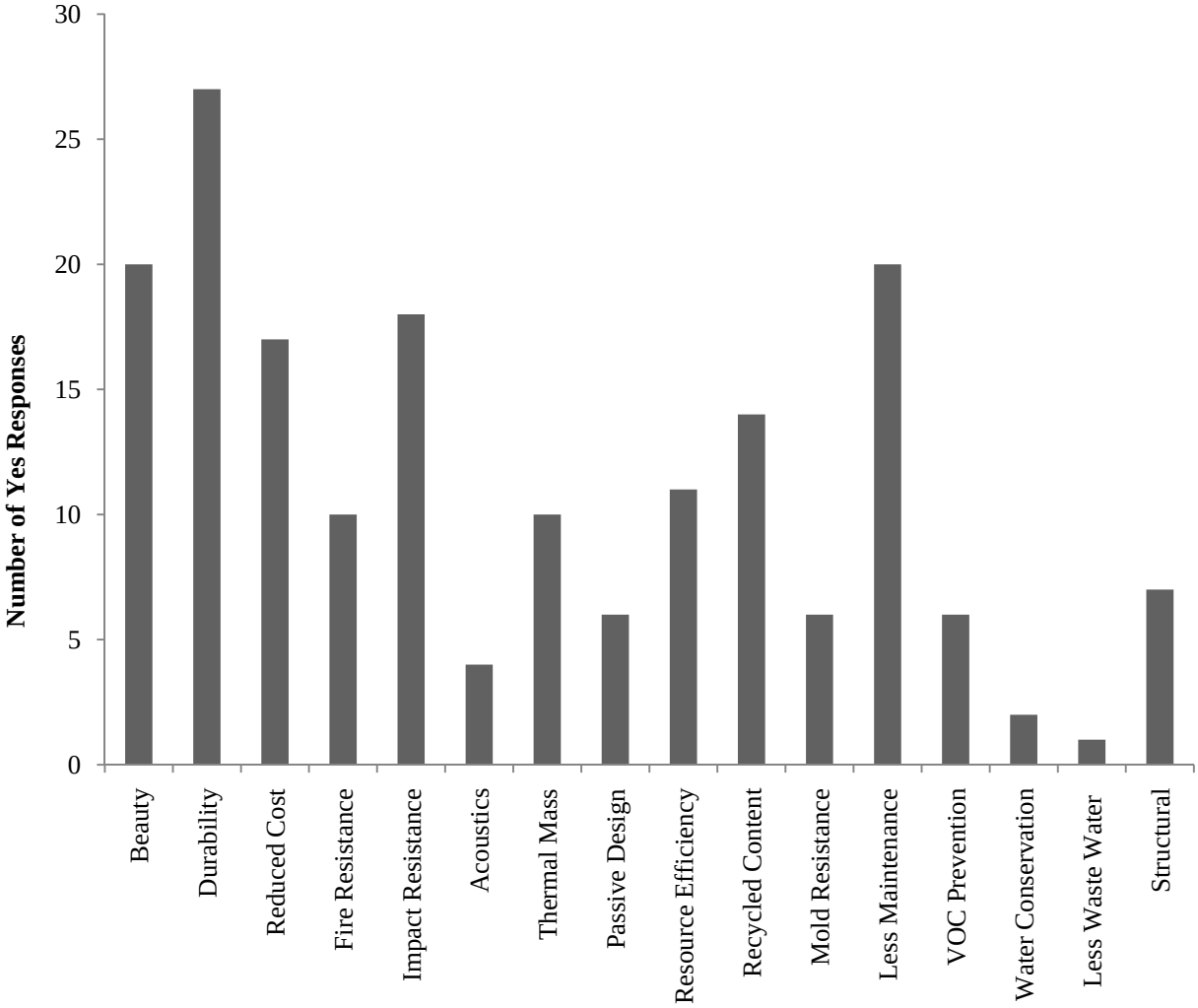


Figure 6: Green attributes of concrete masonry as used in the design

Question 8: Will you please explain briefly how the qualities above have helped you design a better building?

This question would help evaluate the importance of each green attribute of concrete masonry to the building expert.

8a. Aesthetics (Beauty)

About 65% of respondents said that they used concrete block for its aesthetic impacts, while a few asked what the beauty of the building had to do with "green." This is a question that needs more focus. Obviously people tend to demolish ugly buildings and hold on to the pretty ones. This is why beautiful buildings have served as cultural heritage of the past for generations. Buildings with character such as Taj Mahal, Parsa, St. Peters cathedral, and thousands of others around the world are witness to this statement.

Project Name: DMV San Ysidro Field Office
Location: San Diego, CA
Architect: Roesling Nakamura Terada Architects, Inc.
Website: www.rntarchitects.com
Photo Courtesy of: ZOOM Photography, Satoshi Asakawa
Awards and Certifications:
2008 AIA, SDG&E Energy Efficiency Integration Award
2008 AIASD Savings by Design Energy Integration Award
2008 San Diego Architectural Foundation, Orchids and Onions Program, Orchid Award
2007 CMACN, Sustainable Design Honor Award and Public/Civic Design Merit Award
2006 SANDEE Award, Special Achievement in Energy by a Government or Institution

Ruth Fajarit-Davis, project architect for San Elijo Lagoon Nature Center in Encinitas, CA focused on the aesthetic qualities of CMU and related it to its earthy organic appearance, and flexibility:

> "Concrete masonry units were incorporated into the project for their aesthetic qualities, flexibility, durability and affordability. Burnished-face block by a local manufacturer was selected for its exposed aggregate and integral color. The two earth tone colors of CMU were installed in a random pattern for an "earthy organic" appearance complementary to the site. The CMU's flexibility allowed it to be used for both the straight and angled walls as well as the curved sweeping wall of the entry path. The CMU fin walls provide a contrast to the fluid shape of the metal roof above."

Similarly Rick Espana, Associate Architect who designed the DMV San Ysidro Field Office building in San Diego, California said that his "use of concrete masonry in a layered, multi-color pattern was a key design element for conveying the design concept for representing the geology of a striated cliff." He emphasized that the building has "received compliments on the beauty of the material." Espana earned five awards for the building including three for energy efficiency.

Architects should also consider harmony of new buildings in historic districts not to jeopardize the beautiful character of old neighborhoods. In doing so designers can use concrete masonry.

Project Name: San Elijo Lagoon Nature Center
Location: Encinitas, CA
Architects: Zagrodnik + Thomas Architects LLP
Website: www.ztarc.com
Photo Courtesy of: Z+TArch and photographer Pablo Mason
Awards and Certifications:
LEED Platinum Certification from US Green Building Council
Sustainable Communities Champion from San Diego Gas & Electric
Special Achievement in Energy by a Government -SANDEE Awards from California Center for Sustainable Energy)
Honor Award for Sustainable Design from Concrete Masonry Association of California and Nevada
Green Building of America Award from Green Building of America-Southwest
Build San Diego Award" Best Unique Small Project - Public Works Project from Associated General Contractors (to Riha Construction)
California Solar Initiative Recipient (to SD County Dept of Parks & Rec/Riha Construction)
Award of Excellence for Sustainability from National Concrete Masonry Association
Associated Builder & Contractors ABC Award (to Challenger Sheet Metal)
Design Award of Excellence from

8b. Durability

More than 87% of the building experts interviewed said that they chose concrete block for its durability. Unfortunately these projects had not received any LEED points for durability. Most new versions of green building guidelines, standards and codes are defining service life as a sustainable base for green buildings which will encourage the use of durable materials.

Many architects in this survey spoke about the minimal maintenance needed through the life of the Concrete Masonry Units, Segmental Retaining Walls and Concrete Pavers. Low maintenance cost plays a significant role in minimizing Life Cycle Cost of buildings. It also makes for easier operation and maintenance of the building over its service life. Some respondents emphasized the importance of durability- for educational environments and other building types- in room separations and exterior cavity wall systems. Steven J Gloyeske, project architect The Isaac Ray Treatment Center in Logansport, IN states:

> **"**Utilizing concrete brick and block materials for the Isaac Ray Treatment Center provided a material which could withstand the heavy abuse and contact hours of the forensic psychiatric patients; it also provides a crisp and colorful environment. Repair and maintenance costs have been very low in the building due to material selection."

Project Name: Isaac Ray Treatment Center
Location: Logansport, IN
Architects: Scholer Corporation
Website: www.scholer.com
Photo Courtesy of: Jon Denker, CAPS
Awards and Certifications:
LEED NC - Silver, Ver 2.1, awarded August 10, 2006

8c. Reduced Cost

Almost 50% of the building experts in the survey stated that reduced cost was a reason for their choice of concrete masonry. Some mentioned using CMU as a structural element. This eliminated the need for further finishes and therefore reduced cost. Others called CMU an affordable material because of its minimal maintenance costs in the future. Jonah Busick, Director of Merzproject wrote about The Galleries at Turney in Phoenix, AZ:

> "We were able to reduce costs by using a structural material as a final finish. We left the blocks with their natural finish (no paint, stucco etc) thus reducing the need for maintenance and increasing durability."

Along the same lines John Dick, the architect for Queen Creek Library in Queen Creek, AZ said:

> "Masonry allowed us to use a strong, simple material in a bold statement with feature walls, and simple detailing that helped meet budget. It is a material that helped achieve the LEED Gold certification."

8d. Fire Resistance

About 30% of respondents said they chose to use concrete block for its fire resistance. With the growth of demand for denser communities this may increase in the future. Non-combustible materials help sustain buildings through fire, and can save dense neighborhoods and their occupants. This was the reason many cities required "non-combustible construction" after disastrous fires in the 1800's. As green building codes and standards encourage development of denser

Project Name: Franklin Elem. School
Location: Kirkland, WA
Architect: Mahlum Architects
Website: www.mahlum.com
Photo Courtesy of: Benjamin Benschneider
Awards and Certifications:
2006 Top Ten Green Project Award, AIA Committee on the Environment

communities, fire resistance of building materials will become more important. Walkable, dense, mixed-use communities reduce transportation pollution and encourage the use of public transportation. In walkable communities residential buildings need to be tightly spaced, and close to jobs, retail, entertainment and educational facilities. Concrete masonry does not burn or melt in fire. It holds its strength and stays intact. Thus load bearing concrete masonry does not need sprayed-on fire retardants for fire resistance.

Project Name:
Fossil Ridge High School
Location: Ft. Collins, CO
Architect: RB+B Architects
Website: www.rbbarchitects.com
Photo Courtesy of: davidpattersonphotography.com
Awards and Certifications: LEED Silver

8e. Impact Resistance

Close to 60% of the designers chose concrete block because it is resistant to damage. Impact resistance is a factor in minimal maintenance, particularly in high-impact areas. Ruth Fajarit-Davis AIA, LEED AP notes on San Elijo Lagoon Nature Center in Encinitas, CA:

"CMU was also selected for low-maintenance and durability to hold up against the constant use by school children and the public visitors to the Center. The burnished-face block provided the look of natural stone without the cost of stone."

Ruth received LEED Platinum and nine different awards for design of this building.

8f. Acoustics (Sound Absorption)

About 13% of the surveyed designers had used concrete masonry for its sound absorption ability. This is a concept that needs to be followed in future studies. At this point, a limited number of spaces in some building types require special sound-absorption levels. Green building experts developing new standards have started to debate over whether or not reduction of noise pollution is a green concept. If approved, sound absorption will become a priority in material selection for green projects. Johnny Birkinbine, architect for Helen S. Schaefer University of Arizona Poetry Center, said: "The west elevation, comprised entirely of concrete block, is designed with minimal fenestrations providing privacy and a barrier from traffic noise."

8g & 8h. Thermal Mass and Passive Design

About 30% of respondents said their projects benefited from the thermal mass of CMU walls and 20% said they chose concrete masonry for its passive qualities. This is another area where responses may change in future surveys if rating systems start awarding points for passive design strategies. Johnny Birkinbine said of his design of the Cezar Chavez Library in Phoenix, AZ:

"Buildings built in the Sonoran Desert, a climate of harsh extremes, require a special architectural response with proper solar orientation in order to keep energy costs at a minimum. The Cesar Chavez Library is oriented so that the glass primarily faces north and south, allowing natural daylight to fill interior spaces with little or no direct sun. The west elevation is fully masonry with no windows, in an effort to mitigate direct solar heat gain, reducing demand on the building's mechanical system. Concrete masonry wing walls extend into the

Project Name: Cesar Chavez Library
Location: Phoenix, Arizona
Architect: Line and Space, LLC
Website: www.lineandspace.com
Photo Courtesy of: Bill Timmerman
Awards and Certifications:
Project anticipates LEED Silver Certification
NCMA 2008 Project of the Year - Best LEED
Valley Forward Association Crescordia Award for Environmental Excellence
American Institute of Architects Committee on the Environment (AIA/COTE) Top Ten Green Projects of 2008

landscape to retain earth, serve as a windbreak, and provide critical shade to outdoor areas when the sun is low on the horizon." He added: "Earth bermed concrete masonry walls provide thermal mass which significantly lessens demand on the mechanical system."

Jones Studio, Inc also explained in their report for The Pocono Environmental Education/ Visitor Activity Center that they used passive solar heating for the main activity area. The studio reported that mass of concrete block in the southwest wall helped absorb heat in winter.

8i. Resource Efficiency

More than 30% of those interviewed said that they benefited from the resource efficiency of concrete masonry in their design. The modular design of concrete blocks helped them reduce their construction waste by a large factor.

Resource efficiency in production is another major concept that is missing from green building standards. In production of most metals less than 30% of the ore extracted from the earth is turned into building material and the rest goes to landfill. With concrete masonry, more than 95% of mined material turns into CMU, SRW, and pavers. Responsible use of resources calls for more emphasis on this area and future green codes and standards can play a major role by giving resource efficiency its proper position.

8j. Recycled Content

More than 50% of respondents said that they used concrete block with recycled content. The percent of recycled content was as high as 46.5%. Concrete masonry is indefinitely recyclable since it can be repeatedly crushed and used as aggregate for the next batch of concrete masonry without any downgrading. This makes concrete masonry one of the greenest materials. Since recycled concrete masonry is generated locally, it does not have to be transported long distances.

8k. Mold Resistance

Almost 20% of the building experts said mold prevention was an important reason they chose concrete masonry in their green building. This seems low considering the fact that green building promotion has emphasized indoor environmental quality. Mold is a major cause for sick building syndrome which has caused absenteeism in employees in buildings of poor air

quality. Studies have shown that in the United States people spend 90% of their time inside buildings, and thus are greatly affected by indoor air quality. Existing codes and standards have encouraged designers to focus on moisture prevention assuming that they design using products prone to mold. To eliminate the problem entirely material resistant to mold can be chosen. Masonry products do not give mold a food source, preventing the growth naturally. To encourage designers to focus on this concept it should be included in new versions of codes and standards.

8l. Less Future Maintenance

Close to 65% of the survey respondents considered concrete masonry for its little required maintenance in the future. Allen H. Kachel said on Pocono Environmental Education/ Visitor Activity Center in Dingmans Ferry, PA:

> "Materials have been selected throughout the building that are durable, have a long life span, require little or no maintenance and have a low impact on the environment. The masonry used on this project, especially the exposed Ground Face CMU, very much aligned with that intent."

His building was selected as one of the top ten projects by the AIA Committee on the Environment (COTE) in 2008. It also received the 2009 Green Good Design Award from the European Centre for Architectural Art Design and Urban Studies & the Chicago Athenaeum.

Project Name: City of Tucson Fire Station 22
Location: Tucson, AZ
Architect: WSM Architects
Website: www.wsmarch.com
Photo Courtesy of: Cooperthwaite Photography
Awards and Certifications: LEED Gold

8m. VOC Prevention (No Paint)

Almost 20% of respondents said they chose concrete masonry based on this attribute, which is lower than expected. This may be due to the fact that in most cases the design did not use exposed CMU on the interior. Paints, sealants, and interior finishes that off-gas Volatile Organic Compounds are dangerous for the building occupants. Concrete masonry can provide for beautiful exposed exterior and interior surface thus eliminate –in most cases- the need for finishes, sealants, and paints that can be a source of VOC off-gassing. Allen H. Kachel, who designed the Environmental Education / Visitor Activity Center in Delaware, explained:

> "Throughout the building materials were selected that did not require a finish, thereby improving the indoor air quality of the building. The masonry used on this project, especially the exposed Ground Face CMU, very much aligned with that intent."

Project Name: Colorado Court
Location: Santa Monica, CA
Architect: Pugh + Scarpa Architects
Website: www.pugh-scarpa.com
Photo Courtesy of: Marvin Rand
Awards and Certifications:
LEED Gold Certified – First in Nation for Multifamily Housing
Rudy Bruner Prize, 2003
National AIA Honor Award, 2003S
National AIA/COTE, "Top Ten Green Project" Award, 2003
National AIA PIA Award, 2003
AIA/CC Honor Award, 2003
AIA/LA Honor Award, 2003
BHS&F World Habitat Award, Finalist, 2002
Westside Prize for Urban Design, 2002
Exhibited at the National Building Museum in Washington, DC, 2004

8n. Water Conservation in case of concrete pavers

There were two projects that had used concrete pavers in this study. Designers stated that they had used concrete pavers to substitute for turf to reduce the use of irrigation water. As irrigation water conservation becomes more important as a green measure this ratio is expected to increase.

8o. Waste Water Management with sand set concrete pavers

One out of the two projects that used concrete pavers said they used sand-set pavers to manage storm water run-off. Gregory Mella stated on Chesapeake Bay Foundation's Philip Merrill Environmental Center in Annapolis, MD:

> "Concrete Pavers were used for site work", explained Gregory Mella: "because it provides a solid surface for vehicles that is permeable, allowing storm water quantities to be reduce, and allowing ground water recharge. Storm water management was a key aspect of the project."

This project was the first LEED Platinum building in the United States, and it received seven different awards.

8p. Structural

More than 20% of the studied projects used CMU for their structural elements. Some mentioned in their interviews that this helped conserve building material. They also explained that the elimination of finishes and paint made more affordable projects with less future maintenance.

8q. Other

Designers brought up some interesting ideas on other green attributes of concrete masonry. Some talked about security measures such as bullet resistance. Others brought up the hurricane resistance quality of CMU, and others referred to concrete masonry walls as beautiful fencing material, shading devices, wind breakers, and earth retaining elements. A few architects mentioned concrete masonry as a screen where they could engrave, etch, or reflect artwork, poetry or animal tracks.

Allen H. Kachel, designer of Pocono Environmental Education/Visitor Activity Center in Delaware, PA said that he had found it interesting to add environmental figures and shapes onto the wall:

> "The Ground Face CMU also gave us the opportunity to etch the blocks with animal tracks, leaf outlines and other images from nature drawn by children, to further integrate the mission of environmental education into the building."

Michael Bartunek, the designer of Mukilteo Police Station described his use of CMU's in the site: "To secure the site, instead of a chain-link fence topped with barbwire, split face CMU landscaping walls, a wrought iron fence with CMU pillars created a friendlier street image."

Similarly Johnny Birkinbine said about the Poetry Center of University of Arizona, Tucson, AZ said:

> "Concrete masonry was also chosen for one of the most important features of the building the "Binary Wall", a tall screen wall which shields the east windows and Bamboo Garden from the low summer sun while implementing the abstraction of a Richard Shelton poem into binary code. The center-scored concrete masonry unit was a perfect choice for the wall due to its modularity as it relates to the binary system as well as providing protection from the heat of the sun and the noise of surrounding facilities. The coded message "you shall learn the art of silence," is fitting for the garden and its significance is realized through the function of the wall."

Project Name:
Helen S. Schaefer University of Arizona Poetry Center
Location: Tucson, Arizona
Architects:
Line and Space, LLC
Website: www.lineandspace.com
Photo Courtesy of:
Robert Reck
Awards and Certifications:
Project has received local and state American Institute of Architect and masonry guild awards

Question 9: Did you receive any LEED points/ "green" credits for the use of concrete masonry? If yes, for what quality of it?

39% of the survey participants used concrete masonry to achieve LEED points for regional material. Regional materials minimize transportation impacts on the environment, and growth of local economy. LEED points for recycled content were obtained by 28% of the projects. Another LEED credit was energy efficiency with 10% of respondents. It may be that architects do not take into account the effects of thermal mass in their energy calculations. Future studies need to

focus on the effects of thermal mass and passive design on energy conservation in green projects to find out the level of knowledge of designers on this green quality of concrete masonry.

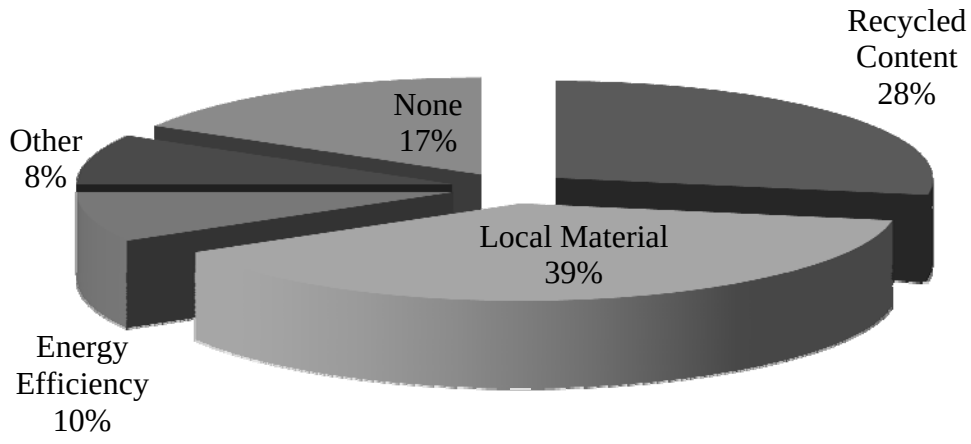


Figure 7: LEED points earned by adding concrete masonry into calculation

Question 10: Have you received any comments from occupants of the building about the use of the concrete masonry?

Most respondents said that they had received comments on the beauty of the building as a whole, and only a couple mentioned that the concrete masonry had been commented on aesthetically.

Question 11: Did you ask the manufacturer for a custom mix for your concrete block to maximize recycled content (fly ash, recycled glass or recycled aggregate in the mix)? What was the outcome?

In most cases the architects said that they did not have to go to custom design and that the manufacturers had standard material with recycled content. A few responded that they had specified the percentage of recycled content while ordering the products.

Question 12: Will you please list any other LEED or "green" projects in your office that have incorporated brick, block or stone?

Most of the architects interviewed had many other projects that they had built using concrete masonry. A few architects mentioned that they used green qualities of concrete masonry in the projects that were not seeking certification from any green rating system.

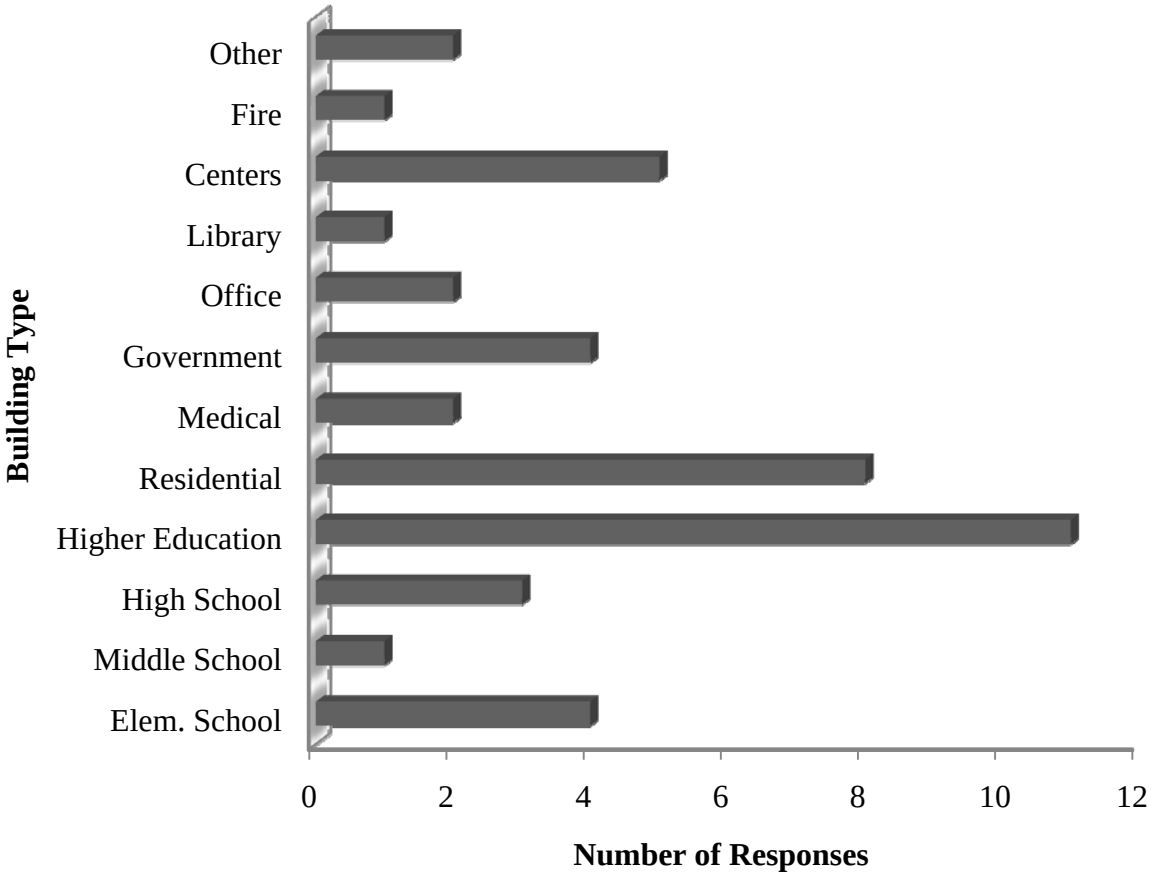


Figure 8: Other green projects designed by the architects interviewed

Conclusions

In the past decade there has been rapid growth in environmental consciousness and the green building movement. Rating systems such as LEED have served as yard sticks for measurement of sustainable design criteria. They have helped educate stakeholders and drive the building industry toward reducing their carbon footprint. Developers of green codes and standards are in search of improving their newer versions incorporating lessons learned.

Along with the growth of green the building movement, research needs to be done on the choice of "green" building materials and their functionability. While post-occupancy evaluations can show the level of user satisfaction in green projects, evaluation of building materials can guide architects in their future design.

The present study showed that besides LEED concepts, emphasis needs to be placed on passive design, long service life, beautiful buildings, minimal maintenance, fire resistance, noise reduction, resource efficiency, mold prevention and VOC reduction through material choice.

Most LEED credits achieved for concrete masonry were regional material with about 33%, and recycled content around 28% of the studied projects. Up to three times as many designers considered concrete masonry green qualities that were not credited by LEED. Durability was considered by about 87% of respondents, beauty and minimal maintenance tied around 65% and impact resistance almost 60% rating. Affordability was the next most important attribute for concrete masonry with about 50% of the studied green projects. Fire resistance, thermal mass, and resource efficiency were considered for around 30% of the projects. And about 20% of respondents considered in their choice of concrete masonry passive design, mold and VOC prevention, and structural considerations.

Building experts who participated in this survey have designed green buildings for a long time. Some of their environmentally sensitive projects date back to 1970's when LEED and other rating systems did not exist. Projects surveyed under this report were up to 8 years old and the same designers received many awards for them. From the 17 LEED certified, 4 Pending LEED registered and 10 never applied for LEED certification. Some respondents put in extra effort to

explain their green objectives in choosing concrete masonry, some of whom were quoted earlier. As part of their design consideration they named many green attributes of concrete masonry that have been overlooked in the existing green rating systems. Concrete masonry has been a popular building material for centuries because of its inherent green qualities, and needs to be justly recognized for them.

Work Sited

Bonda, P. (2008). Cesar Chavez Library. Green Source**:** 92-95.

Brosnan, D. A. (2002). Selling Brick to Architects and Building Owners Using Sustainability**:** 1-6.

Dell'Isola, Alphonse J. and Stephen J. Kirk. Life Cycle Costing for Facilities. Kingston, MA: Construction Publishers and Consultants, 2003.

Gragg, R. (2008). Pocono Environmental Education Center. Green Source**:** 96-99.

Keoleian, G. S. C. Evaluation of LEED Using Life Cycle Assessment Methods. National Institute of Standards and Technology:1-159.

Kieran, C. (2008). Garthwaite Center. Green Source**:** 100-103.

Koerner, P. (2009). "Palm Springs LEED Platinum Contender." 2009, from http://wwwjetsongreen.com/2009/03/palm-springs-leed-platinum-contender.html.

Koerner, P. (2009). "Stunning LEED Galleries at Turney." 2009, from http://www.jetsongreen.com/2009/01/modus-development-galleries-at-turney-green-homes.html.

Lasch, D. (2008). "Arizona Masonry Guild Announces 2008 Architectural Awards Winners." 2009, from http://www.masoncontractors.org/newsandevents/masonrtheadlines/headline.php?id=20081114073746.

Sokol, D. (2008). COTE D'Azure. Green Source**:** 60-65.

VanGeem, M. G. (2009). Life Cycle Inventory of Concrete Masonry and Concrete Hardscape Products, Part 1 Progress Report. J. Thompson, CTl Group**:** 1-8.

White, S. G. a. D. The Skilled Worforce Shortage, National Center for Construction Education Research**:** 1-8.

Wilson, A. (2008). Toward Wiser Water Strategies. Green Source**:** 108-114.

"Architerra Projects, Cambridge School of Weston." 2009, from http://www.architerra-inc.com/ArchiterraHome.html.

"Ausonio Incorporated." from http://www.ausonio.com/index.html.

"Award Winning School Designs." 2010, from http://www.innovativedesign.net/awards.htm.

Banner Gateway Medical Center. Gilbert, AZ, NBBJ Architects**:** 1-2.

"Banner Gateway Medical Center." 2009, from http://www.nbbj.com/#work/projects/banner-gateway-medical-center.

"Benjamin Franklin Elementary School." 2009, from http://www.mahlum.com/projects/franklin/index.asp#.

“Bohlin Cywinski Jaskson." 2009, from http://www.bcj.com.

"Boulder Training Facilities." 2010, from http://www.rothsheppard.com/pages/boulder-fire-training.

Coconino Community College. Flagstaff, AZ, Jones Studio Inc.**:** 1-7.

"Coconino Community College." 2010, from http://www.jonesstudio.com/16/index.htm.

"Colorado Court." 2009, from http://www.pugh-scarpa.com/projects/colorado.court.

"Department of Motor Vehicles, San Ysidro Field Office." 2009, from http://www.rntarchitects.com/design/civic/sydmv.html.

"Douglas County Elementary Prototypes." 2009, from http://www.rbbarchitects.com/projects/project.aspx?ProjectID=26.

Embodied Energy Considerations in Existing LEED Credits**:** 1-7.

"Find A Chapter." 2009, from http://www.usgbc.org/DisplayPage.aspx?CMSPageID=191.

"Ford Center for Environmental and Conservation Education." 2009, from http://www.smithgroup.com/?id=422.

"Fossil Ridge High School." 2009, from http://wwwrbbarchitects.com/projects/project.aspx?projectID=5.

"Fossil Ridge High School, Project Profile." 2010, from https://www.usgbc.org/ShowFile.aspx?DocumentID=3940.

"The Galleries at Turney." 2010, from http://www.merzproject.com/work.php.

"Garthwaite Center." 2009, from http://greensource.construction.com/projects/0807_GarthwaiteCenter.asp.

"Grand Opening of New Fire Station 67 in Playa Vista." 2009, from http://westcoast911.com/wp/2008/02/13/grand-opening-of-new-fire-station-67-in-playa-vista/.

"Green Building Materials." 2009, from http://www.calrecycle.ca.gov/GreenBuilding/materials/.

"Green Source." 2010, from www.greensource.constuction.com.

"Greening Schools." 2010, from http://www.greeningschools.org/.

"Isaac Ray Treatment Center." 2009, from http://www.usgbc-in.org/projects/?id=17.

"LEED Certified Projects." 2009, from http://www.eypaedesign.com/leedprojects.

"Legat Architects- Press Release." 2009, from http://www.legat.com/?_p=news,press-release,2009,10-06-09.

"Line and Space." 2009, from http://www.lineandspace.com/main/.

Mukilteo Police Station. Mukilteo, WA, DLR Group**:** 1.

Northern Guildford Middle School. North Carolina, Innovative Design Inc. **:** 1-9.

"Our Work." 2009, from http://www.o2arch.com/OUR_WORK.html.

"Philip Merrill Environmental Center." 2009, from http://www.smithgroup.com/index.aspx?id=637&section=34.

"Pocono Environmental Education Center." 2009, from http://greensource.construction.com/projects/0807_PEEC.asp.

Pocono Environmental Visitor Activity Center. Dingmans Ferry, PA, Bohlin Cywinski Jackson**:** 1-41.

"Queen Creek Library." 2009, from http://activerain.com/blogsview/1135182/queen-creek-library.

"Queen Creek Library." 2009, from http://www.dfdg.com/cultural-a-religious/queen-creek-library.

"R.L. Binder, FAIA Architecture and Planning." 2009, from http://www.binderarchitects.com/pages/home-r3.html.

Reedy Fork Elementary School. North Carolina, Innovative Design Group**:** 1-6.

"Roy Lee Walker Elementary School." 2009, from http://www.shwgroup.com/portfolio/walker.html.

"San Diego Green, San Elijo Lagoon Nature Center is LEED Platinum." 2009, from http://www.sandeigo.com/green/san-elijo-lagoon-nature-center-is-leed-platinum.

"San Elijo Lagoon Nature Center." 2009, from http://sdpublic.sdcounty.ca.gov/portal/page?_pageid=93,284203&_dad=potal&_schema=PORTAL.

"Step Up on Fifth." 2009, from http://www.pugh-scarpa.com/projects/step.up.

"Sustainable School Design." 2010, from http://www.innovativedesign.net/sustainableschools.htm.

"Tucson Fire Department Station 22 and Battalion 4 Headquarters." 2009, from http://www.wsmarch.com/publicsafety_firestation22.htm.

"U.S. Green Building Council." 2010, from www.usgbc.org.

"University of Southern Maine, Abromson Community Education Center." 2009, from http://usm.maine.edu/abromson/.

"Yavapai College ASTC." 2009, from http://www.dlrgroup.com/#/3.16.5/.

"Zagrodnik + Thomas Architects, LLP." 2009, from http://www.ztarch.com/.

(2003). Coconino Community College. Concrete Masonry Design**:** 10-12.

(2006). Green Buildings and the Bottom Line, Building Design and Construction**:** 1-64.

(2006). Map of the Nation's Platinum and Gold LEED Certified Projects, The McAdams Group, Funding Green Buildings, and Platinum Development: 1-3

(2007). Department of Motor Vehicles, San Ysidro Field Office. CMU Profiles in Architecture**:7**

(2007). ICC Green Building White Paper**:** 1-12.

(2008). "AIA COTE Top 10." 2009, from www.aiatopten.org.

(2008). "The CBF's Philip Merrill Environmental Center." 2009, from http://leedcasestudies.usgbc.org/overview.cfm?ProjectID=69.

(2008). Cesar Chavez Library Concrete Masonry Designs**:** 6-8.

(2009). Banner Gateway Medical Center. Concrete Masonry Designs**:** 6-9.

(2009). Brick Brief, The Brick Industry Association**:** 1-3.

(2009). Measures and Verification, Tapping into ARRA Stimulus Funds, On Set**:** 1-5.

(2009). Regional Materials in Green Building Rating System- Calculating Credit, The Brick Industry Association**:** 1-3.