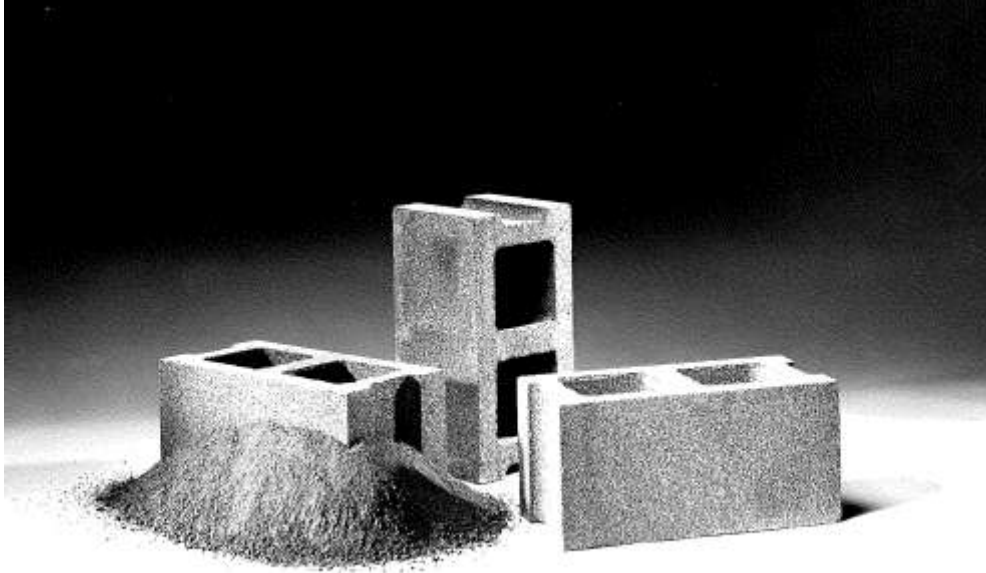


Recognizing the Sustainable Virtues of Quality Lightweight Concrete Block Masonry



In 1914, Frank Lloyd Wright lost his wife and several members of his household when a servant burned down Taliesin, his home and studio in Wisconsin. Following the tragedy, he redirected his architecture toward more solid, protective forms. Although he produced few works during the 1920's, Wright theoretically began moving in a new direction that would lead to some of his greatest works.¹ He made a move toward utilizing sustainable and durable materials in his future designs.

As early as 1914, Wright was designing and using textured concrete block in his buildings. Concrete block did not become popular in the United States until after WW II, when many small manufacturers began making it from native materials.² High powered, technologically advanced machinery could then mass produce concrete block for general construction.

Late in 1957, a Chicago patent attorney notified the NCMA that its application for a trademark of its name had been approved. A few months later, delegates to the NCMA convention heard an aging Frank Lloyd Wright (1867-1959) discuss his love affair with concrete block.³ The concern was about the quality of concrete block produced by so many producers.

Introducing Expanded Shale and Clay (ES&C).....

State-of-the-art machinery, a proven curing process, and a commitment to quality are earmarks of the best concrete block manufacturers. Block manufacturers evaluate concrete mix constituents for their impact on the block manufacturing process. Many block manufacturers employ the use of ES&C because experience has taught them its value. They have learned that the cost of not using ES&C is more important than the price of using a low quality lightweight aggregate. That's because, in many aspects, expanded shale and clay lightweight aggregate performs "better than code". Contact TXI representatives to learn why.

ES&C is manufactured from naturally occurring shale and clay. Rotary kiln furnaces heat the raw feed to temperatures of about 2000°F, creating a hot, pyro-plastic flow that has been expanded during the process. Clinker, the resulting cooled material, is a ceramic-like material similar to the composition of clay-fired brick. The clinker exhibits a matrix of tiny pores surrounded by vitrified shale or clay. It is from this clinker that crushing and screening produces a specified gradation. From this final phase, structural-grade lightweight aggregate is manufactured for the lightweight concrete block industry.

- Is manufactured to exacting grading specifications
- Is not a waste product
- Does not contain potentially harmful industrial contaminants
- Less abrasive on machinery and parts allowing for longer service life
- No potential liability from using waste or cinder-type constituents.

Top Ten Sustainable Virtues Of Quality Lightweight Concrete Block Masonry

“Concrete and Concrete Masonry are viewed as Durable and Sustainable construction materials. This review goes beyond these general qualities and focuses on the contribution to Sustainable Construction offered by Lightweight Concrete Block Masonry Using ES&C Lightweight Aggregate”

- ES&C is a sustainable aggregate.
- Improved Energy Performance
- Durability & Service Life (LCC)
- Improved Fire Resistance and Ratings
- Wall Weight is Reduced
- Less Virgin Material Is Used
- Reduced number of trucks and handling
- Reduced Seismic Inertia
- Workforce Sustainability and Mason Productivity
- Mold – A Product of Wet Buildings

1. **ES&C is a sustainable aggregate.**

Shale and clay, as natural deposits, are one of the most plentiful raw materials on the earth. However, in themselves, they are generally not useful as a concrete aggregate. These raw materials are expanded into a quality, structural-grade aggregate for concrete by our manufacturing process. Locating heavy weight aggregate deposits suitable for concrete aggregate is getting tougher and more regulated. ES&C lowers demand on finite sources of natural sand and gravel and helps improve their sustainability and useful life. Also, due to its lightweight, more aggregate is shipped per truckload than heavy aggregate, effectively reducing the carbon footprint of transportation.

Why should your next design include lightweight masonry using TXI ES&C?

2. Improved Energy Performance

Those involved in green building are more aware that the emphasis of building design should be directed to attaining lower life cycle costs. What is desired is reducing energy demand through an integrated design process involving all the project's stakeholders. As it has in the past, designers wanting substantial design form build with concrete. And lightweight concrete masonry is a viable choice to substantially reducing energy demand on your next project.

Lightweight block building envelopes excel in energy performance. Admittedly, energy efficiency is a complex topic and it's important to look at all aspects that impact performance. R-values are a quick way to rate *insulation* but there are properties of lightweight concrete masonry that contribute to energy savings. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (2007) considers the factors of ***thermal mass, thermal bridging, and insulation***.

Designers know that concrete will store heat. Referred to as "thermal mass", this attribute makes masonry slow to respond to temperature changes. Thermal mass evens out temperature change and this results in specifying smaller, yet effective, HVAC systems. R-value requirements are substantially reduced due to the use of thermal mass. IECC 2009 recognizes lightweight masonry has having adequate weight to provide the required thermal mass to qualify for the masonry mass wall exceptions.

While thermal mass storage is generally understood, thermal inertia, an interesting characteristic related to thermal mass, is less obviously understood. Heat movement (conductivity) is reduced by concrete of lower density. In heavier concrete masonry, higher concrete densities increase thermal mass, but lower the wall's thermal resistance. It is the combination of the two factors, mass and thermal inertia, which determines how the wall envelope contributes to building thermal performance in a dynamic environment. Lightweight masonry walls store less heat when compared to heavier mass walls. However, they release the stored heat more slowly. This attribute will contribute to improved overall building thermal performance.⁴

In addition to the above quality of thermal inertia, lightweight block exhibits less thermal bridging than heavier units. In concrete block masonry, webs connect the inner and outer face shells. Heat must travel through those webs, the course of "least resistance". Lower density lightweight masonry reduces thermal bridging. Typical 135 psi density concrete masonry units,

even when cores are insulated with foam, only improve R-value about 79%. When lower density concrete block is insulated with foam, the R-value is increased 216%. As the example shown in the following table illustrates, there is reduced thermal bridging through lower density concrete webs.⁵

R-value Example Using Typical 8" Block		
Density of Concrete, pcf	85	135
Empty Cores, R	2.5	1.9
With Polyurethane Foam, R	7.9	3.4
% Improvement	216%	79%

3. Durability & Service Life (LCC)

When lightweight masonry is properly designed and installed per plans and specifications, the building envelope will contribute to low maintenance costs similar to other masonry or concrete wall systems.

To illustrate the energy cost performance of using lightweight block masonry, a study was made in 1996 by comparing lightweight concrete masonry with tilt wall and heavy block masonry⁶. In the Houston, Texas study, the annual energy cost per square foot for a building opaque wall area of 38,367 square feet using a tilt wall envelope with no insulation was estimated to be \$ 4.49 per sq. foot of wall area. Heavier block with no insulation was about \$ 2.99 sq. ft., a 33% improvement over tilt wall. Lightweight concrete masonry with no insulation was about \$ 2.39 per sq. foot, a 47% improvement over tilt wall. In this example, the wall envelope using standard lightweight block makes a significant contribution even when using whole building energy modeling. Of course, using insulation will offer more savings as illustrated in Item 2 above.

Lightweight masonry construction first-costs are equal or less than tilt wall and heavy block masonry in general. Due to its thermal benefits, lightweight masonry offers accelerated pay back benefits over its estimated 100 year life cycle.⁷ It's worth doing the analysis on your next job because that is what green building is all about.

In the U.S., buildings account for 72% of all energy consumption in construction and operational phases and 38% of all carbon dioxide emissions.⁸ Reducing energy demand through green building strategies is vital. Life-cycle cost analyses permit a comparison of different designs and identify the best long-term investment – the approach that offers the lowest overall cost of ownership consistent with the project goals and available resources.

TXI ES&C Lightweight masonry – it's worth taking another look.

4. Improved Fire Resistance and Ratings

Build extra-safe using “best practices” when you choose your wall envelope system selection. You can be sure that lightweight masonry using TXI ES&C lightweight aggregate will hold up under extreme fire temperatures, providing premium-level protection for fire fighters and occupants alike. In many cases, the walls are left standing or are even salvageable.

ES&C has been tested over many decades for its performance in a fire and is listed as an approved aggregate type when fire ratings are critical. While not the “lightest” of all types of lightweight aggregate, manufactured expanded shale and clay has proven itself to be the “sweet spot” when weight to strength ratios are considered. There are no ignitable materials in ES&C. Waste products and other type of aggregates may contain harmful or combustible materials even when meeting minimum code requirements. And ES&C is not a source of off-gassing of harmful chemicals or VOC's.

Green design often means thinner masonry can be specified in order to obtain specific fire ratings. The designer can rest assured that lightweight masonry using ESC lightweight aggregate have exhibited superior performance in the case of fire events. See www.txiesc.com/pdf/Fire-Ratings.pdf for helpful information on fire ratings and performance of lightweight masonry using block made from TXI ESC.

5. Wall Weight Is Reduced

The weight of masonry is important to engineers for structural reasons. The wall weight is referred to as “dead load”. With heavy concrete walls, the supporting foundation requires broader and deeper beams (more concrete) and more reinforcement (more steel). And let's not forget about lots of additional labor. Not very sustainable when you think about it. Typical reinforced lightweight masonry weighs about 24% less than typical normal weight masonry.⁹

Note: ASTM C 90 – 06b Standard Specification for Loadbearing Concrete Masonry Units provides for three concrete density classifications for block.

Concrete dry densities are Lightweight = less than 105 pcf, Medium Weight = 105 to less than 125 pcf, and Normal Weight = 125 pcf or more. Since we are discussing ASTM Lightweight specifications, it would be helpful to give examples of the maximum weight, in the field, of a typical ASTM Lightweight concrete block, in popular widths for 8" high X 16" length standard block. Of course, lighter density block is available by adjusting the ratio of lightweight aggregate and heavier weight aggregate. Contact your block producer for assistance.

Maximum Field Weight of ASTM Lightweight Block

Width of Block, nominal	Block Field Weight, lbs
6 inches	23.5
8 inches	30.7
10 inches	33.8
12 inches	38.8

Above field weights include 5% moisture content, which can vary. Dry density of 104.9 pcf was used for the above examples.

Count the Ways TXI ES&C Lightweight Masonry can be incorporated into your next design.....

6. Less Virgin Material Is Used

In many instances, engineers can design taller walls with lightweight masonry. For example, due to high strength/weight ratios, thinner masonry can be designed for taller walls. In many instances, 12" wide heavyweight masonry can be re-designed using 10 or 8 inch wide lightweight masonry. Through value engineering, many masonry walls can be built while utilizing these green building practices.

And it is a well-known fact that masonry in general uses far less material than concrete tilt-up or pre-cast construction. Typically, block used in structural masonry contains up to a 15% void matrix¹⁰ in the concrete itself. And concrete masonry contains the familiar open core geometry where cores can be partially grouted when reinforcement is used.

Much is discussed regarding Portland cement and its generation of CO₂. Many design efforts focus on using less concrete or in using supplementary cementitious material (SCM) to replace a portion of the cement.¹¹ A typical 10,000 s.f. of wall area using tilt wall construction will require about 58 tons of cement (no SCM) used in the concrete and this would generate about 72 tons of CO₂.¹² A typical lightweight concrete masonry wall system would use about 30 tons of cement (no SCM) generating about 38 tons of CO₂. A truly green advantage when compared with tilt wall construction. This reduces the CO₂ from this example by about 48%.

Can you imagine what can you build with TXI ESC Lightweight Masonry?

7. Reduced number of trucks and handling

For same wall size areas, concrete masonry materials are delivered to the project location using fewer trucks when compared to ready-mix concrete. While concrete walls, such as tilt wall or ICF, are also durable and sustainable in themselves, the fact is that truckloads of material are typically reduced up to 47% by using lightweight concrete masonry.

Fewer truckloads also reduce the carbon footprint of trucking during construction, not to mention reduced traffic congestion on the site and on highways. Masonry does not require the use of large pieces of equipment, such as cranes or large concrete pumps. Smaller staging areas during construction and masonry construction strategies help reduce the development footprint, enabling construction to take place in restrained urban sites as well as protect previously undeveloped land.

“We didn’t have big machinery. It was all small stuff, like the cement mixed in a stationary cement mixer. We dug banks out there with a pick and shovel. It was all done by hand, a lot of hand.” – Glenn Work, mason on “Fallingwater” by Frank Lloyd Wright, January, 1936.

The delivery of concrete masonry complements scheduling issues and is not as time-sensitive as fresh concrete. Better management and control can often be realized. Lightweight masonry products fill available space on each truckload without sacrificing space due to less weight. In these cases, more material can be shipped per truckload than heavy-weight concrete products.

It is a green building practice to reduce carbon emissions during construction and building with lightweight concrete masonry reduces CO2 by using fewer trucks. Using fewer trucks also improves their service life.

How can you build with the design flexibility of TXI ESC Lightweight Masonry?

8. Reduced Seismic Inertia

Many engineers in seismic prone areas are very familiar with the benefits of lightweight concrete block masonry. This strategy addresses earthquake forces by reducing the weight of the wall system, specifying higher masonry strengths, and providing sufficient reinforcement to overcome seismic inertia. This can be further enhanced by using lightweight grout instead of normal weight grout. In many cases, buildings can be constructed in locations not available for construction due to soil conditions. See TXI for guidance on the use of lightweight grout (lightweight grout requires engineers approval).

When required, ES&C aggregate is the perfect material for high-strength lightweight masonry. The angular and porous surfaces of the ES&C particle provide excellent particle-to-particle interlock. The cement-to-particle “contact zone” will also be strengthened. The absorbed moisture in the particles will continue to provide long-term strength improvements that contribute to durability and sustainable design. Note: This additional moisture does NOT contribute to concrete drying shrinkage as it is not immediately available to the cement. See TXI for further information about internal curing.

The improved mortar joint interlock with the textured surface of lightweight block improves the mechanical bond of the joint resulting in better performance of in-plane loading due to seismic force. Another element that improves safety margins in masonry design.

WHERE can you build with TXI ESC Lightweight Masonry?

9. Workforce Sustainability and Mason Productivity

Installing lightweight concrete block masonry helps to reduce workplace injuries due to lighter weight. Over the years, many workers develop chronic injuries due to the lifting and handling of heavy concrete products.

While a typical 8x8x16 lightweight concrete unit itself can weigh about 26 pounds normal weight units typically weigh in around 36 pounds. The general 27% difference in weight of same-size block helps to insure that well-trained and experienced masons are sustained and stay on the job longer, experiencing fewer injuries and lost time.

Production benefits: While no one production rate fits all jobs, we generally mean by “production rate” the number of units a mason can lay in one day under normal conditions. The main influence on production rate is usually the weight of materials.¹³

As an example, consider typical 12” wide lightweight blocks weighing 37 pounds compared with normal weight blocks weighing 53 pounds. According to our reference, this would result in a 34% increase in productivity per block-laying mason. Productivity influences speed of construction, an important sustainable element during the building operation.

Lightweight Masonry – A Weight off the Shoulders of Our Masons

10. Mold – A Product of Wet Buildings

Masonry construction adopts the concept that buildings should have a life expectancy of 100 years. Many design professionals understand that during that time, all buildings will experience “moisture events” of various natures.¹⁴ Regardless of its source, moisture often comes into contact with most building components, especially the building envelope. Knowing this, lightweight masonry walls used as a substrate, backup, or as the exterior finished wall will withstand moisture events and mold growth without serious damage – dramatically reducing maintenance and cleanup costs. Locate the moisture problem, dry it, and clean it. Demolition and rebuilding never enters the equation. And as most now know, concrete is not a food source encouraging mold growth.

The double-wythe masonry system has built-in redundancy that insures water intrusion through the wall envelope is never allowed to reach the interior of the building. Also, when even more economy is desired, such as for warehouses, water intrusion prevention strategies can be employed in single wythe masonry.

¹ www.architectureweek.com/2009/0318/index.html and

www.greatbuildings.com/architects/Frank_Lloyd_Wright.html

² June 25, 1987, The Washington Post, Constance Stapleton, author

³ “From the Carriage Age to the Space Age” – The Birth and Growth of the Concrete Masonry Industry, Joseph Bell and Contributors

⁴ Ask the Expert, PCA Article by John Ries, Expanded Shale and Clay Institute

⁵ NCMA TEK 6-2b, R and U Values of Single Wythe Masonry Concrete Walls

⁶ COMPARE!, an Energy Efficiency Scoping Tool for Architects and Engineers, ZenTech Consultants, L. Walden, P.E.

⁷ NCMA TEK 8-1A, Maintenance of Concrete Masonry Walls

⁸ Energy Information Administration. 2005.

⁹ 8x8x16” block masonry walls, grouted 32” o.c.

¹⁰ Block Concrete Is a Structural Material, T.A. Holm, Journal of Testing and Evaluation, 1976

¹¹ “Concrete Builds the Sustainable Movement”, PCA

¹² www.BuildingGreen.com/features/flyash/appendixa.cfm

¹³ Masonry Estimating by Rynold V. Kolkowski, page 184

¹⁴ Are You Building a School or a Liability? A Guide to Total Masonry Construction in Public Schools, TMC, Chris Huckabee, AIA and Kyle Montgomery, 2004