Until the end of the 20th century, masonry thrived simply because it is non-toxic, strong, durable, fire resistant, made of abundant materials and locally produced. Now it must also be sustainable.

But those are the qualities of a sustainable material!

As we look at buildings that have sustained themselves through the years, we see masonry construction. Masonry has always been a sustainable material. Masonry construction has intrinsic qualities that make it a sustainable construction system, but these qualities must now be verified using contemporary measures.

This is not a call for new marketing strategies by the masonry industry. It is a call for rigorous analysis to document benefits, identify any problems and find even more innovative manufacturing, design and construction solutions.

Material qualities that are not objectively measured count for very little in this era of measurable rating systems. Evidence of a material’s qualities must go beyond anecdotes to include data gathered through sound research. For instance, until the masonry industry credibly documents the long life of masonry assemblies, rating systems may continue to assume they last only 30 to 60 years, to the detriment of masonry.

Architectural Merit
To be sustainable, people must want the building to be sustained. Sustainable architecture means making beautiful buildings that have a character and quality that people will love. Good design is essential to sustainable architecture. There is nothing about masonry units that cause the building to be beautiful. But their variety of colors, textures and sizes, incorporated into the design by imaginative architects, combined with the mason’s skill in placing them, make beautiful results.

Sustainable design is an opportunity to use our resources efficiently, while creating healthier living and working environments, while also enhancing the quality of buildings and cities.

American Institute of Architects (AIA) strongly advocates for sustainable design and construction. A variety of resources are available through the AIA. Visit aia.org/practicing/groups/kc/AIAS077433.
Buildings represent nearly half of the CO₂ emissions in this country and more than a third of the energy use. Nothing else has a larger share. The AIA has set clear goals for reduction of both and for meeting other important objectives of sustainable design. Manufacturers, builders, architects, engineers and clients all have a role to play in meeting these goals. We should not assume the goals will be met by the other person, the other company, the other industry or the other country. All designers, builders, owners and occupants of buildings have a role to play in meeting these challenges. All will benefit when the challenges are met.

AIA Sustainability Discussion Group created the 50 to 50 position statement: “The 50 to 50 is a range of PRINCIPLES of sustainability which, when embraced individually or collectively, will help practitioners move projects toward AIA’s immediate goal of 50% reduction of project fossil fuel consumption.” Masonry can contribute substantially to many of the 50 principles, but the focus here is on one of those.

Life Cycle Assessment

One of the AIA 50 to 50 principles states “The evaluation of the environmental impact of a product or service throughout its lifespan is a cradle-to-grave analysis which looks at the materials used to create a product or service from their extraction to their return to the earth. LCA includes the assessment of production of raw material, manufacture, distribution, use and disposal, all transportation required, as well as an analysis of pollution caused by usage, damages such as global warming, smog, ozone depletion and more.”

LCA strategies advocated in 50 to 50 include several that masonry can readily address:

• Design for long life and adaptability
• Use durable low maintenance materials
• Use locally sourced materials to reduce transport
• Select low embodied energy materials preferably based on supplier-specific data
• Specify standard sizes; don’t use energy-intensive materials as fillers

The AIA Sustainable Rating Systems Position Statement supports the use of rating systems and standards for design and construction, but stipulates that sustainable rating systems such as LEED, Green Globes and others must:

• Recognize life cycle value

Life cycle assessment data as the basis for design and construction decision making

Life cycle assessment is an attempt to broaden life cycle analysis beyond cost factors to include all of the environmental factors associated with building materials, such as embodied energy used for each material. This has been called the ‘cradle to grave’ perspective; more relevant might be the full cycle ‘cradle to cradle’ perspective, first attributed to Swiss sustainable researcher/architect Walter R Stahel and advocated by William McDonough.1

Life Cycle of a building material, with associated environmental impacts

• Source of material Extraction of material from nature, recycled or some combination
• Transport Means, distance and type of fuel
• Industrial processes Refining, fabrication of finished product, energy types and quantities, byproducts of processes
• Construction and maintenance processes Energy types and quantities, byproducts of processes, maintenance or repair during building life
• Building operation Energy types and quantities for illumination, heating and cooling, indoor air quality, outdoor air and water quality impact
• Deconstruction or demolition Energy types and quantities, byproducts of processes
• Reuse of components and recycling of materials Energy types and quantities, byproducts of processes

Note that the second item states that LCA data should be the basis for decision making, not merely a basis, underlining its primacy over many other factors.

Beyond benefits to the environment, LCA can be required by regulatory bodies and may be encouraged by public or private sector clients in order to achieve lower operating costs, healthier facilities or perhaps a desirable “green” status. Some projects will need rigorous LCA calculations, which should be third party/peer-reviewed and should utilize standardized means of analysis such as ISO 14040.

Utilize life cycle assessment data as the basis for design and construction decision making

1wiki.aia.org/WikiPages/Home.aspx
2mcdonoughpartners.com/design_approach/philosophy
Sustainable Masonry Design

- Disposal of waste: Air and water quality impact, transport means, distance and type of fuel

Sustainable Architecture

For thousands of years, masonry buildings were thick barrier walls in which masonry served as structure, enclosure, thermal regulation, moisture resistance and many other functions. In the mid-twentieth century, masonry veneer became the dominant type of masonry wall, with a brand new set of principles to guide its design and construction. As masonry walls evolve, designers and builders are challenged to master principles relevant to the particular type of wall they are creating.

In terms of life cycle cost, masonry out-performs other building materials

Following are some common sense principles for sustainable architecture, relevant to both traditional barrier walls and contemporary drainage walls, when we are trying to maximize sustainability.

Design buildings and assemblies that:
- are durable and easily maintained (long life)
- are loosely tied to a particular program, adaptable (loose fit)
- have a quality, character, specific features that people will love; people maintain things they love
- avoid trendy features that date-stamp a building; avoid obsolescence of style
- are simple; avoid needless complexity
- anticipate the end of the service life, maximize residual value, minimize waste

Select building materials that:
- are reused, renewable or abundant, nontoxic and preferably available locally
- are durable enough to last for hundreds of years
- age gracefully and minimize demand for maintenance
- use safe and commonly available processes of manufacturing and construction
- minimize waste from manufacturing or construction processes

...involve small energy and carbon dioxide investments compared to anticipated service life
- are resistant to environmental deterioration, such as biological or chemical attack
- are resistant to deterioration due to human contact, such as fire, impact or blast
- are simple and attractive, that can serve multiple functions, such as structure, enclosure and finish
- are reusable, recyclable or safely disposable locally when initial use is complete

Among others, masonry materials typically have these qualities. Few are currently rewarded by LEED-NC.

Masonry buildings are so durable that they remain useful for hundreds or even thousands of years with very little maintenance. They are typically made using local materials. They are free of toxic substances, are inert and produce no harmful gasses. Masonry products can even safely encapsulate toxins within them, permanently removing them from the environment. Their thermal mass can reduce peak demand for heating and cooling and shift that demand off of the utility company’s normal peak. Color, texture and scale of masonry products give the designer many choices. Buildings made using masonry structure and enclosure systems are intrinsically fire resistant, impact resistant and blast resistant. Their spaces can accommodate varied functional programs, including programs that are not anticipated when the building is first constructed. They seldom expire due to natural deterioration; masonry materials normally last the life of the building.

Innovation

Every industry is evolving to rediscover itself in terms of sustainability. Along with a rush of new building materials, traditional building materials such as masonry are called upon to discover new product refinements, new production processes and new tools for designers.

Masonry production is decentralized; there are 668 concrete masonry producers in the US and 83 clay masonry producers, for a total of over 750 different companies. These companies affiliate in many ways, but not all. They seldom share practices that help them compete against other masonry producers in the marketplace.

The result is that there is little centralized research regarding masonry design or manufacturing. Demand for sustainable materials began in about 1990. Now, 20 years later, many sectors of the construction industry are little changed, other than increased green marketing. This is the time for the masonry industry to take the lead in energy efficient manufacturing and in use of recycled products, rescuing tons from landfills.

Abundant Materials Preferred; Diminishing Materials must be Reused or Recycled

All materials are valuable and should be used efficiently. Those less abundant than others must be used more sparingly and should be reused or recycled when their initial service life has completed its cycle. Conversely, the potential to recycle a material at the end of its service life cycle is a lesser imperative if that material is abundant or renewable. This principle is especially viable if disposal of the material causes no environmental harm.

Sustainable designers must plan for the long term. Diminishing and nonrenewable materials should be used with care, especially if those materials are diminishing at a rapid rate.

Some minerals used in building construction are predicted to be uneconomical to extract in as little as a single generation.

Materials Assessment

Figure 1
For example, copper: 36 years, tin: 28 years, zinc: 21 years, lead: 20 years.

Preference should be given to abundant, non-toxic minerals such as stone, gravel, sand, clay, earth, gypsum, lime, perlite, quartz and silica. Masonry products use these abundant resources and have long service lives. For such materials, recyclability is a lower priority.

Figure 1 illustrates this principle. The worst materials to choose would be those that are not abundant/renewable and which are also not reusable/recyclable.

The best materials would be those that are abundant/renewable and which are also reusable/recyclable.

In the other two quadrants of the diagram, preference is given to those materials that are abundant or renewable.

Useful Life

There is very little data regarding how long buildings normally remain in use, making accurate LCA calculations difficult. However, available data certainly suggests that the service life of a masonry building is more than the 30 to 60 years anticipated in some life cycle assessment tools. In Europe and much of the world, a 100-year-old building isn’t considered very old.

In the UK, 25% of the 23 million residential properties are more than 160 years old. Most of these are of brick or stone.

A careful study by the Athena Institute of Residential and Non-Residential Buildings that were demolished in a representative city (Minneapolis/St. Paul) between 2000 and 2003 showed that 51% of the buildings were at least 75 years old; the largest concentration of buildings fell into the 76-100 year age group. Only 30% of the buildings were less than 50 years old; 13% were more than 100 years old.

It is likely that environmental impact is much less if we build one 100-year building, rather than four 25-year buildings. Masonry is a good choice for a 100-year building.

Within any building’s life span, some components will expire sooner than others. To achieve sustainability with minimal impact, the designer must anticipate the service life of each.

Permanent components such as foundations, structural systems and exterior walls are long service life elements, whereas roofing and interior finishes tend to have shorter service lives.

Design Strategies

If the component is to have a relatively short service life, the appropriate strategy is to design for minimal resource consumption, using construction systems that lend themselves to easy disassembly. These building components should be from recycled or renewable materials and should be efficiently recycled.

If the component is to have a long service life, it may be more important to use materials that are robust and durable with few maintenance obligations.

Design criteria for these two strategies are quite different. Greater investment of environmental resources such as energy and special materials can be considered in long-life components because the investment is prorated over many more years. Rating systems currently do not

4Paola Sassi; Strategies for Sustainable Architecture; Taylor and Francis; 2006
5Stephanie Lewis; “Cradle to Cradle; A Study in Durability and Adaptability”, Green Building Insider, June 2008
6Sustainability of Construction Materials; Jamal M. Khatib, Editor; CRC Press; 2009; citing: UK Department of Communities and Local Government / 2006
7athenasmi.ca/about/docs/Demolition_Survey.pdf /July2007
take durability or service life into account; they evaluate all materials as if they have equal service lives. A material’s recyclability can be low if its durability is high, and conversely, its durability can be low if it is easily recycled.

Masonry can be used in any strategy, but is most suited for long service life components, due to its intrinsic durability and minimal need for maintenance.

Strategy #1 in Figure 2 is best for a building that is anticipated to have a medium to long service life. In Strategy #1, the initial investment is prorated over the assembly’s longer service life.

Strategy #2 is a commonly chosen hybrid, in which renovations or repairs occur at intervals over the life of the building to regain function or quality lost due to deterioration or other reasons.

Better research data is needed to document the value of building in such a way that reduces demand for future repairs

Strategy #3 is an unacceptable strategy. Resources are consumed to produce a level of function and quality which is high initially, but which declines quickly.

Masonry is an appropriate choice for strategies 1 and 2.

In Figure 3, Strategy B may initially be more costly than Strategy A, but may be justified due to favorable life cycle performance. Use of durable, low maintenance materials in initial construction may increase initial costs, but may be justified if they offer favorable future performance features. Initial cost is an investment that avoids future costs. Adverse environmental or social impacts may also be reduced.

As with any assessment of value, the task is to compare the initial investment to the anticipated quality of performance over the product’s service life. The initial investment required to produce materials with a long service life is prorated over a longer period of time. Their value may be greater than another material with a lower initial investment, but which has a shorter service life and requires more maintenance. See Strategy A in Figure 3.

**Durability Undervalued in Rating Systems**

The best empirical rating system regarding sustainability is to simply observe the world’s existing building stock. Masonry construction has a strong representation in this ‘survival of the fittest’ rating system. The best evidence that masonry is a sustainable building material is the fact that it is the predominant material used in historic structures that still exist today providing continuous service for hundreds of years with minimal maintenance. In terms of life cycle cost, masonry outperforms other building materials.

However valid the concept, the value of building durably may be difficult to quantify. Perhaps for that reason, masonry is recognized in current green rating systems chiefly in the categories concerning regional production and material resources. Better research data is needed to document the value of building in such a way that reduces the demand for future repairs, renovations and reconstruction.

Many consider the number of credits given by LEED-NC Materials and Resources to be disproportionately low compared to the environmental value of these features. This is controversial and may change in future versions of the rating systems. Tools designers use to weigh options regarding sustainable materials and designs are quite new and the priorities regarding environmental impact change as circumstances change. We should anticipate that debate will continue and that the tools for sustainable design will continue to evolve.

**Competitive Strategy**

In order for owners, designers and green rating system organizations to truly understand and embrace life cycle assessment’s role sustainable building, the masonry industry must be prepared to deliver on the following statements:

- Masonry construction has many qualities that align with sustainable design objectives
- Many qualities that make masonry an excellent choice for sustainable projects are not broadly understood. They are often under-rewarded in rating systems
- More research is needed to quantify the value of masonry in sustainable building design
- Challenges of the 21st century will be solved by manufacturers, architects and builders collaborating to find new solutions at each step in the process
- The best sustainable designs apply common sense and have a long term perspective. "Green building" may be glamorized by the new, the different and the unusual. However, when used properly, traditional construction materials such as masonry can play a central role in sustainable design and construction.

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