The Greening of Mortar

Cement companies take responsibility for adopting new processes to reduce energy consumption

Sustainable Development as defined by The World Commission on Environment and Development is “Development that meets the needs of the present without comprising the ability of future generations to meet their own needs.”

Masonry construction contributes to sustainable development by its energy efficiency, lowering of the heat island effect and reduced carbon footprint. Masonry products are made with local materials, and are 100% recyclable.

Governments, corporations and citizens are now demanding responsible energy use as a response to the fear of continued global warming. A performance driven building envelope system using insulated masonry cavity wall construction along with its thermal mass can reduce energy consumption by up to 50% over the lifetime of the building. The unique energy saving advantage inherent in masonry buildings is its thermal mass. This is the ability of materials to absorb energy slowly and release it. Thermal mass will reduce spikes in heating and cooling requirements, reduce heat transfer through massive elements and help shift energy demand to off peak time periods.

Historically, the production of construction materials and building practices focused predominantly on profitability and first costs of construction. Organizations like the US Green Building Council (USGBC) are changing the way we look at construction. Surprisingly, initial construction only comprises 3–13% of the building’s lifetime energy consumption. On the other hand, operation of the heating and cooling systems throughout the lifetime of the building contributes substantially to energy consumption.

Masonry building systems also help minimize the urban heat island effect, where microclimate temperatures are raised in developed areas, contributing to increased energy use as a result of increased building cooling demands. Heat islands also have adverse health affects associated with elevated smog and ground ozone levels. One of the ways to reduce the heat island effect is to use light colored masonry with a high albedo (solar reflectance) material with a reflectance of 0.3 for at least 30% of the site’s non-roof impervious surfaces.

Environmentally friendly mortars

Did you know that masonry cements and mortar cements used in unit masonry construction are the most environmentally friendly mortars in use today? They utilize locally available materials and have a substantially smaller carbon footprint than portland cement/lime mortars since they are produced with 25%-55% interground limestone and clinker with functional processing additions to achieve the characteristics necessary to produce mortar for masonry construction.

The clinker factor or cement factor in mortar represents the portion in mortar that uses the most energy and emits the most greenhouse gases during production. Raw materials used to produce portland cement are predominantly limestone and silica with minor additions of iron and alumina. Mined or reclaimed from by-product streams of other industries, they are combined prior to calcination and fusion in a cement rotary kiln. This energy intensive process requires temperatures in excess of 2700°F in the kiln. The resulting material, clinker, is then interground with gypsum (for set control) and functional process additions in grinding mills. During the kiln process, calcination of the carbonate materials (limestone) results in the emission of CO₂. The result is that 0.96 tons of CO₂ is released into the atmosphere for each ton of clinker produced.

The CO₂ footprint of masonry and mortar cements is dramatically lower than portland cement/lime mortars predominantly from the ‘clinker’ factor or the amount of clinker per ton of masonry, mortar or portland cement produced. The CO₂ footprint is then approximately, 0.38, 0.56 and 0.90 tons per ton of material used in making mortar using masonry cement, mortar cement or portland/lime cement, respectively.


Specifications

ASTM C270, Standard Specification for Mortar for Unit Masonry permits the use of each of the materials either by proportion or by property specification. Mortar design by

In 2006, the St Marys Charlevoix plant installed a new indirect firing system that reduced both fuel consumption and emissions. The plant also replaced power plant fly ash with on-site shale, overburden, and purchased bottom ash to reduce mercury emissions. Close to a residential area, the facility conducted a noise study that led to the design and installation of silencers resulting in less noise for the surrounding community. Working with the Michigan Department of Natural Resources, St Marys maintained a fish-stocking program for the Chinook salmon fingerlings and worked to encourage the regional resurgence of the bald eagle by constructing nesting platforms on its property. A local newsletter is distributed to inform the local community about environmental projects at the plant.
prescriptive methods in the Proportion Specification Requirements specifically states which materials to use in the production of mortar and their proportions. Mortar design according to Property Specifications permits the use of any of the material components with requirements on the properties of the mortar.

**Energy reduction**

The portland cement industry has made great strides in reducing energy consumption over the past 20 years. Modern plants use a ‘dry process’ that moves fine materials pneumatically and reclaim heat in various stages of production for use in other areas in the process.

In an effort to lessen the impact of virgin material extraction, cement companies use industrial waste in two ways; as a replacement to virgin materials extracted for use in their raw mix or as a supplement to fuel. By-products from other industries used as raw materials in cement clinker include: taconite (an iron-bearing, high silica, flint-like rock used in steel manufacturing), fly ash (by-product of coal combustion in generating electrical power), granulated blast furnace slag cement (by product of the steel industry ground into a fine powder), foundry sand generated by the metal casting industry and mill scale, a surface layer of ferric oxide that forms on steel or iron during hot rolling. Use of these materials saves energy and helps save valuable landfill space. By-product materials used to supplement fuel demands in the production of clinker and cement are petroleum coke, a hard substance like coal produced from the petroleum refining process, shredded tires and automotive paint waste and solvents. Cement manufacturing requires very high temperatures (2700°F) to initiate the chemical reactions necessary to make cement. The extremely high temperatures and long residence time ensure complete combustion of any by-product fuels.

Utilization of non-traditional alternative fuels not only helps save precious natural resources like oil and coal but also dramatically lowers carbon-based emissions. The Portland Cement Association has been instrumental in getting ASTM and ANSI to change their cement specifications, to adopt the use of 5% limestone addition to be interground into portland cement which will help lower the carbon footprint by lowering CO2 emissions and saving energy. European and Canadian specifications currently allow this change in formulation.

**Supplementary cementitious materials**

Used in the production of mortar for unit masonry, supplementary cementitious materials (SCMs) are by-products of other industries that may possess hydraulic or pozzolanic properties and contribute to strength development when used with portland cement in concrete and mortar. They can be added to the cementitious portion of the mortar or can be interground or blended into masonry, mortar or blended cements used in the production of the mortar. Use of SCMs in the production of mortar gives the added benefit of reducing the clinker factor of the mix, thereby reducing the carbon footprint even further. Two predominant supplementary materials that are used are granulated blast furnace slag cement and fly ash.

Both of these products can be used as a supplemental raw source for portland cement production, thereby lowering the demand on limestone extraction, reducing energy usage and lowering CO2 emissions. These materials also work well in the manufacture of concrete block and ready mixed concrete. If these products are not used by the cement industry and the concrete industry, they would end up in a landfill.

**Sensible and sustainable**

As a rule of thumb, mature masonry markets use approximately 10% of the portland cement production in the production of mortar for masonry construction. The U.S. cement industry produced approximately 89 million tons of cement and this suggests approximately 9 million tons of cement were used in masonry construction. Selection of materials to produce mortar for masonry can make a difference in the environment by reducing CO2 emissions substantially.

Masonry construction also saves energy and money by being durable and requiring minimum maintenance. From a health and safety perspective, masonry construction is fire and mold resistant. When old masonry buildings come to the end of their intended use, they are easily adaptable for new occupancy use. Extending an existing building’s life conserves resources, reduces waste and greatly reduces the life cycle cost of the building. Brick, block and stone from old masonry buildings can be easily reused in new masonry construction, preserving history for future generations. Recycled materials reduce the effects of extraction and processing of virgin materials.

Most of the block, brick, sand and mortar used in masonry construction is produced locally from naturally occurring raw materials. This reduces the environmental effect of transportation and supports the local economy. The masonry crew is likely to be made up of the local labor force. Consequently, a majority of the money spent on masonry construction will go back into the local economy.

Unit masonry construction is one of the most popular methods of construction in the world. We see the use of brick, block and stone bound by mortar every day in our lives and have come to accept their use as commonplace. With all masonry’s inherent attributes, especially maximizing energy performance and conservation, we question why it is not used even more.

Masonry construction is environmentally friendly and sustainable. It lasts longer, is less expensive to maintain, is inert, fire resistant, mold resistant and reduces the heat island affect. Masonry materials are produced locally and are 100% recyclable.

So why would you not build green by building with masonry?

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1 The Brundtland Commission report, Our Common Future, (Oxford University Press 1987), The World Commission on Environment and Development

For more information on cement, concrete and mortar in Sustainable Design visit the Portland Cement Association at www.concretethinker.org