Kyoto Opportunities for the Masonry Industry

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ABSTRACT

The Kyoto treaty came in to force on the 16th February, 2005. It will have profound impacts for industry as it will affect the economics of production as well as the materials out of which masonry products are made.

Member nations, including Canada, are wondering how they can meet their objectives and this paper argues that the masonry industry can play a major role.

Canada has the resources and markets close at hand to take advantage of the Kyoto treaty by generating carbon credits through delivering more sustainable technically innovative masonry product based on magnesium oxide and supplying resources to other countries to enable them to meet their Kyoto objectives doing likewise.

KEYWORDS

Carbon credits, masonry units, magnesia, Kyoto, sequestration, mitigation, abatement, sustainable, CO_2, waste, embodied energy, tec-cement, eco-cement.

INTRODUCTION

The Canadian masonry industry is well placed to take advantage of the Kyoto treaty through understanding of and action in relation to the following fundamental truisms.

> *Global warming will only be solved as an economic process*[1]
> *"The technology paradigm defines what is or is not a resource."(Pilzer, P. Z., 1990)*
> *Resources are what people buy because they have value to them*[2].

Let me explain.

THE KYOTO TREATY

On the 16th February 2005 the 1997 Kyoto Protocol, drawn up in Kyoto, Japan in 1997 to implement the United Nations Framework Convention for Climate Change, finally became international law.

Signatory countries are legally bound to reduce worldwide emissions of six greenhouse gases (collectively) by an average of 5.2% below their 1990 levels by the period 2008-2012.

For the protocol to become law it needed to be ratified by countries accounting for at least 55% of 1990 carbon dioxide emissions. The key to ratification came when Russia, which accounted for 17% of 1990 emissions, signed up to the agreement on 5th November 2004. Ratification of the agreement means Kyoto will receive support from participating countries that emit 61.6% of carbon dioxide emissions.

Member countries have developed their own methods to meet targets. The EU for example has established quotas and a market to buy and sell credits. Unfortunately however some major emitters

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[1] John Harrison
[2] General knowledge

have not joined making it difficult for resident companies to trade their credits. The official view in the US and Australia is that it would ruin their economies.

It will be a difficult task for most of the member countries to meet their Kyoto targets and already nations are falling behind their targets. Spain and Portugal in the EU were 40.5% above 1990 levels in 2002. The Japanese are also uncertain about how they will reach their 6% target by 2012.

ISSUES FOR THE INDUSTRY TO CONSIDER

1. **Canada, one of the first countries to sign, has increased emissions by 20% since 1990, and authorities have no clear plan to reach their target.**

2. **The magnesium and magnesium minerals industries in Canada are languishing.**

Particularly noticeable are the large number of closed asbestos[3] mines and mountains of asbestos tailings. New magnesium developments are on hold.

The use of magnesium compounds to make sustainable masonry products will not only lift the magnesium and masonry industries but help Canada meet its international obligations.

NEW TECHNOLOGY, NEW MARKETS

Global warming will only be solved as an economic process[4]

Anybody who thinks that we will achieve greater levels of sustainability and reduce our net emissions because it is moral, sensible or in some other way the right thing to do is a fool.

These processes will only occur through the interaction of supply and demand in markets as shown in **Figure 1**.

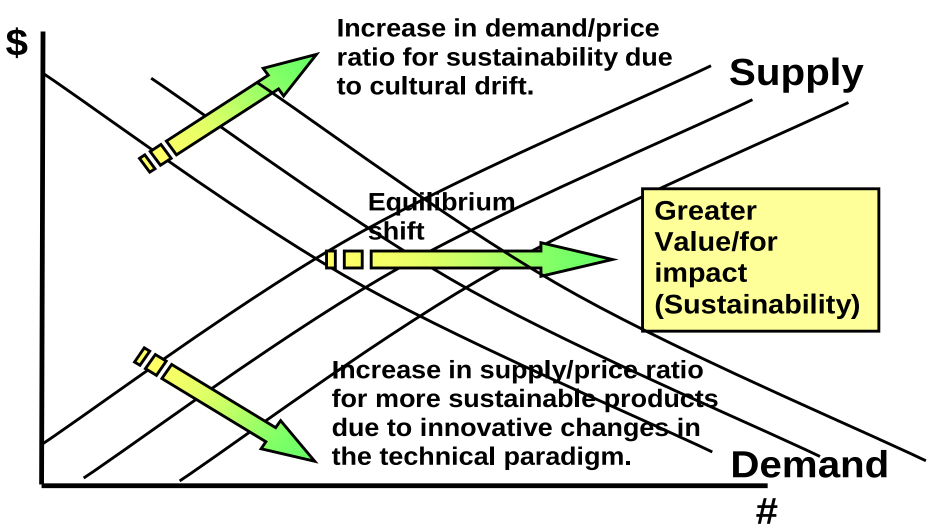


Figure 1 - Achieving Sustainability as an Economic Process

The demand for sustainability and emissions reduction technologies is growing rapidly. Some countries have Kyoto objectives to drive demand policy; even non signatories like Australia are

[3] Asbestos contains considerable Mg.
[4] John Harrison

through government policy stimulating demand as doing so is perceived as sensible. People at the "grass roots" level are also becoming concerned about sustainability issues and modifying their demand behaviours accordingly. Markets are still however immature and the supply side is only just starting to produce the technical paradigms that will deliver "sustainability".

Changing Demand Behaviors

Resources are what people buy because they have value to them[5]

A new culture demanding more sustainable product is emerging. The relevance to the masonry industry is that more than half the world's population is housed with bricks or blocks of some kind or another and there is a market for more sustainable masonry products.

Changing Technical Paradigms

Underlying the enormous flow of materials around the planet are molecular flows in the global commons that are damaging such as too much CO_2, heavy metals etc. Only be re-engineering materials can we change the underlying molecular flows.

Significant changes in our technical processes will reduce our impact on the planet.

A fundamental principle of economics is that

The technology paradigm defines what is or is not a resource.(Pilzer, P. Z., 1990).

By changing the technical processes that deliver masonry products we can fix many of the associated environmental problems. My own contribution is eco-cement, tec-cement and the TecEco kiln technology.

There are two ways of making bricks blocks pavers and mortars, the substance of the masonry industry, more sustainable. These are:

- Use product with much lower embodied energies and emissions and that preferably utilize wastes (e.g. fly ash, bottom ash, industrial slags etc.) Tec and Eco-Cements can achieve this.

- Capture emissions during the manufacture of cements which can be achieved with TecEco Tec-kiln technology.

ECO-CEMENTS

Eco-cements are made by blending reactive magnesium oxide with conventional hydraulic cements like Portland cement. They are environmentally friendly because in porous concretes the magnesium oxide will first hydrate using mix water and then carbonate forming significant amounts of strength giving minerals in a low alkali matrix. Many different wastes can be used as aggregates and fillers without reaction problems. The reactive magnesium oxide used in eco-cements is currently made from magnesite (a carbonate compound of magnesium) found in abundance.

When added to concrete magnesia hydrates to magnesium hydroxide but only in porous materials like bricks, blocks, pavers and porous pavements will it absorb CO2 and carbonate. The greater proportion of the elongated minerals that form is water and carbon dioxide and they bond aggregates such as sand and gravel and wastes such as saw dust, slags, bottom ash etc. Eco-Cement can include more waste than other hydraulic cements like Portland cement because it is much less

[5] General knowledge

alkaline reducing the incidence of delayed reactions that would reduce the strength of the concrete. Portland cement concretes on the other hand can't include large amounts of waste because the alkaline lime that forms causes delayed and disruptive reactions.

The more magnesium oxide in and eco-cement and the more porous it is, the more CO2 that is absorbed. The rate of absorption of CO2 various with porosity from quickly at first to slowly towards completion. A typical eco-concrete block would be expected to fully carbonate (i.e. full absorption of CO2) after a year or so. Eco-cement also has the ability to be almost fully recycled back into cement, should the concrete become obsolete.

TEC-CEMENTS

Tec-cement is made by blending a small amount of reactive magnesium oxide with conventional hydraulic cements like Portland cement. As the magnesia hydrates it consumes water adding to strength because there is a direct relationship between strength and the amount of water added over a wide range. This is basically because the denser concrete is the better. Lime produced as a result of the hydration of Portland cement is consumed by what is known as the pozzolanic reaction with silica and alumina and replaced by brucite which is magnesium hydroxide and a much more stable and less soluble alkali. The result is that durability is significantly improved as well.

Many other properties of concrete are favorably affected including the flow characteristics (rheology) and dimensional change.

Tec-cements are more complex to understand than eco-cements but like them are relatively low alkali and therefore can be used as a repository for a large range of waste materials some of which can contribute properties to the resulting composites.

TEC-KILN TECHNOLOGY

The TecEco kiln is unfortunately somewhat secret due to patent matters. It is the equipment required to enable our **grand plan to sequester massive amounts of CO_2** (See Figure 3) using magnesium compounds in building products such as masonry. Using TecEco kiln technology it will be possible to run a sequestration cycle based on the magnesium thermodynamic cycle whereby MgO scrubs CO_2 out of the air and becomes a carbonate and then what is not used in the built environment as bricks, blocks pavers etc. is re-calcined back to MgO in a closed system so no CO_2 is returned to the atmosphere.

The kiln has the following features:

- Grinds and calcines at the same time.
- Runs 25% to 30% more efficiency.
- Can be powered by solar energy or waste heat.
- Brings mineral sequestration and geological sequestration together.
- Captures CO2 for bottling and sale to the oil industry (geological sequestration).
- The products – CaO &/or MgO can be used to sequester more CO_2 and then be re-calcined. This cycle can then be repeated.
- Suitable for making reactive reactive MgO.

SUPPLYING SUSTAINABILITY - TECECO ECO-MASONRY PRODUCTS

Masonry products made using tec or eco-cement are more “environmentally friendly” than Portland cement masonry products. This is because:

- Eco-cements set by absorbing CO2
- Tec-cements require less cement for the same strength.
- Both tec and eco-cement can contain more wastes as raw materials than any competing technology.

Masonry products made using the technology:

- Are corrosion resistant to the chemical agents that attack Portland cement.
- Have high thermal mass / low embodied energy/ insulating (depending on aggregate) properties and are favoured for energy conserving buildings
- Recyclable (eco-cements). Fire Retardant (eco-cements).
- Low pH (Tec and eco-cements)

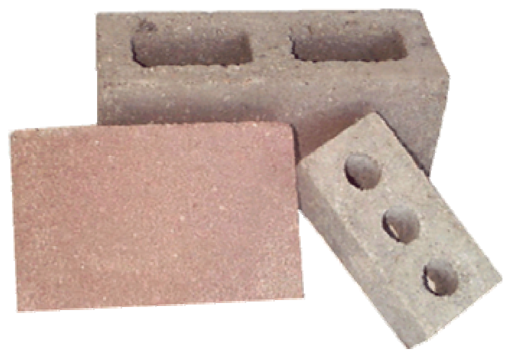


Figure 2 - TecEco Eco-Masonry Products

Eco-cement mortars set by carbonating.

CANADIAN MASONRY TAKING ADVANTAGE OF KYOTO

The Canadian masonry industry is ideally placed to take advantage of the Kyoto protocol to solve the world's global warming problem as the country:

Making bricks, blocks, pavers and mortars using tec or eco-cements in Canada would help the country meet its Kyoto objectives and together with the raw materials required provide a new export. Canada:

- Is close by countries that are big emitters (Europe, the US)
- Has abundant Mg minerals suitable for a silicate reactor process to sequester CO_2 from concentrated sources such as power stations etc.
- Has abundant non fossil fuel energy (hydro, wind) to power TecEco kilns
- It is closed to market that could use Mg carbonate products with associated carbon credits

The business opportunity is between the power industry who will be seeking to reduce carbon taxes, what's left of the once huge magnesium industry as it is a way of profitably using their reserves and tailings and the masonry industry as it is a way of making highly exportable product.

Under Kyoto member countries have agreed to reduce net emissions. This means that as well as a reduction in emissions there is a role for sequestration. The protocol does not concern wastes but as wastes have embodied energies it is arguable that recycling represents reductions in new energy usage.

Construction is the biggest business on the planet and accounts for some 70% of all materials flows. Masonry has a large share of production and the construction industry impacts on the wider environment in a number of ways.

A high proportion of pollution incidents occur in the industry. Construction and demolition waste alone represent a high but unknown proportion of total waste. Too many buildings are environmentally inefficient and do not make best use of limited resources such as energy and water. The energy used in constructing, occupying and operating buildings represents a high proportion of all greenhouse gas emissions in industrialized countries[6]. The built environment is our footprint on the planet.

Canada can meet its Kyoto objectives and at the same time reduce its footprint and profitably make the built environment much more sustainable.

TecEco technology will impact significantly on the masonry industry. There are a number of opportunities for improved sustainability that are relatively **easily achieved**:

- Utilizing wastes to make masonry products.
- Reducing emissions during the production of masonry.
- Sequestering carbon by utilizing carbon containing materials.
- Using the right sands for carbonating mortars to allow them to carbonate.

Utilizing Wastes to Make Masonry Products

Carbon wastes such as sawdust and timber from construction if taken to landfill eventually becomes methane which is a greenhouse gas 21 times worse than CO_2. It would be better to reduce this kind of waste. As an alternative it could be used to create new building materials that permanently sequester the carbon component. Examples include products made with sawdust/chips and wood waste such as building panels and many sound reflecting or insulating panels. A recent breakthrough has been the invention of tec, enviro and eco-cements by my company which being low alkali reduce reaction problems with organic materials.

Non organic wastes including building materials or other wastes taken to landfill can also be used and the concrete industry is already utilizing high proportions of pozzolanic industrial wastes. Again, TecEco cements contribute by allowing even greater proportions to be used.

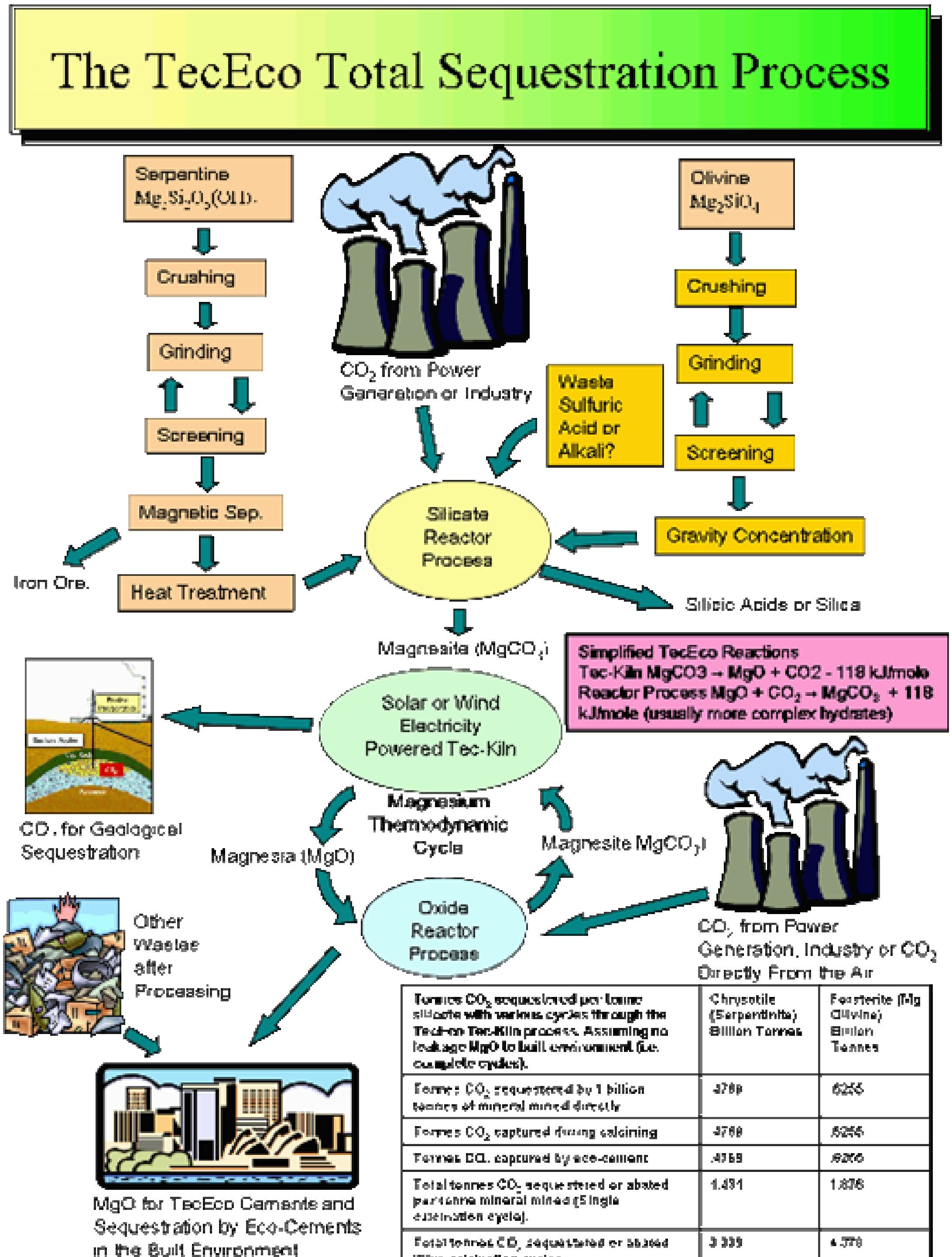
Many wastes can contribute physical property values. Take plastics for example which are collectively light in weight, have tensile strength and low conductance. Tec, eco and enviro-cements will allow a wide range of wastes to be used for their physical property rather than chemical composition and as over two tonnes of concrete is produced for every man woman and child on the planet there is huge scope.

Reducing Emissions During the Production of Masonry Products

Building materials, including clay bricks use energy during their manufacture and are said to have embodied energy.

According to the CSIRO in Australia Clay bricks have about 4.7 Gj t-1, whereas concrete blocks come in lower at 2.1 Gj t-1(Tucker, S., 2002).

[6] Unfortunately there is a paucity of statistics and it is very hard to compare as measurement criteria vary.



Tonnes CO_2 sequestered per tonne silicate with various cycles through the TecEco Tec-Kiln process. Assuming no leakage MgO to built environment (i.e. complete cycles).	Chrysotile (Serpentinite) Billion Tonnes	Forsterite (Mg Olivine) Billion Tonnes
Tonnes CO_2 sequestered by 1 billion tonnes of mineral mined directly	.4769	.6255
Tonnes CO_2 captured during calcining	.4769	.6255
Tonnes CO_2 captured by eco-cement	.4769	.6255
Total tonnes CO_2 sequestered or abated per tonne mineral mined (Single calcination cycle).	1.431	1.876
Total tonnes CO_2 sequestered or abated (Five calcination cycles)	3.339	4.378
Total tonnes CO_2 sequestered or abated (Ten calcination cycles).	5.723	7.506
Total tonnes CO_2 sequestered or abated (Twenty calcination cycles).	11.446	15.012

Figure 3 - The Grand Plan to Sequester Massive Amounts of CO_2

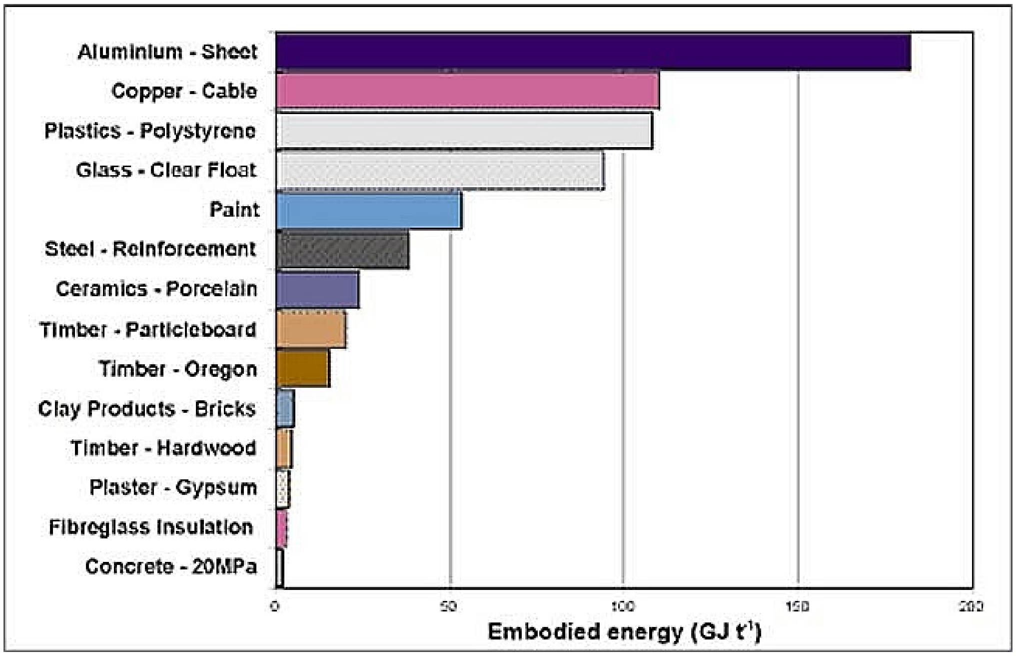


Figure 4 - Embodied Energy of Building Materials (Tucker, S., 2000)

Unfortunately the concept of embodied energy does not include chemical releases of gases as is the case for example with the manufacture of Portland cement used in the manufacture of concrete bricks blocks and pavers.

The challenge is to reduce net embodied energy and chemical releases. One obvious direction is to utilize more renewable energy and especially non carbon cycle renewable energy such as solar and solar derived energy. Another is to eliminate gaseous emissions.

Future sustainability improvements will also involve capturing gases during manufacture and this is easiest for a magnesium component as demonstrated by my company using tec-kiln technology characterized by calcination and grinding in a closed system and the use of non fossil fuel energy.

Sequestering Carbon by Utilizing Carbon Containing Compounds

During earth's geological history large tonnages of carbon were put away as limestone and other carbonates and as coal and petroleum by the activity of plants and animals.

Sequestering carbon in the built environment mimics nature in that carbon is used in the homes or skeletal structures of most plants and animals.

Figure 5 - Biomimicry - Houses of Carbon

Carbon can be used as components of building materials in basically two ways:

As a Fiber, Filler or Massing Component

The use of waste organic fibres such as discussed above is becoming increasing popular. For example James Hardie Industries manufacture a product called Villaboard which includes wood fibre. In the US there are currently many papercrete homes being built. Another interesting product is Zelfo which is a plastic like material made from cellulose and potentially from wood waste.
In Canada there is even a standard on masonry units made containing wood.

The use of carbon is not limited to cellulose and derivatives. Previously mentioned was the example of plastics and other companies have made use of rubber waste.

In Australia TecEco have made thousands of blocks utilising various wastes so there is no reason why this could not also be done in Canada.

As a Binder

The concept of using carbon as a binder is not new. After all ancient and modern carbonating lime mortars are based on this principle. TecEco have now taken the concept a lot further however with the development of eco-cement (see previously) which is based on blending reactive magnesium oxide with other hydraulic cements. Eco-cements only carbonate in porous materials and this is why the masonry industry is so well placed to take advantage of the technology.

Magnesium is a small lightweight atom and the carbonates that form contain proportionally a lot of CO_2 and are stronger. The use of eco-cements for block manufacture, particularly in conjunction with the previously mentioned closed system kiln also invented by TecEco (The Tec-Kiln) would result in sequestration on a massive scale. As Fred Pearce reported in New Scientist Magazine (Pearce, F., 2002), "There is a way to make our city streets as green as the Amazon rainforest".

Using the right sands for carbonating mortars to allow them to carbonate

Lime mortars are actually very common; unfortunately however the sands that are being used are suitable for hydraulic binders not carbonating binders. If the right sands were used additional strength would ensue as the result of proper carbonation. Papers on this subject are available for download from the TecEco web site and will be presented at this conference.

CONCLUSION

There will be no bigger business than the business of saving the planet and the Canadian masonry industry have a unique opportunity to sell the world masonry products product containing carbon and other wastes, resources enabling other countries to sequester carbon in a similar way and carbon credits.

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