MASONRY INSTITUTE OF BRITISH COLUMBIA

CCMPA Building Strength
Canadian Concrete Masonry Producers Association

Concrete Masonry & the LEED® Recycled Content Credit

Recently, the construction industry has seen an increased emphasis on sustainable design and building green by governments, design professionals and building owners. The concrete masonry industry must participate fully in this arena if it is to maintain and expand its position in today's construction marketplace.

A measurement system is required if buildings are to be evaluated for their environmental performance. LEED (not LEEDS!) stands for "Leadership in Energy and Environmental Design", and has become the dominant evaluation system in North America. It was developed in the U.S. and has been chosen for adaptation by the Canada Green Building Council (CaGBC). LEED Canada-NC 1.0 was issued in late 2004. Projects can be qualified as LEED Certified, Silver, Gold or Platinum based on the number of points achieved from a variety of credit categories.

The existing credits in LEED Canada cover most, but not all of the ways in which concrete masonry can contribute to sustainable design in buildings. "Recycled Content" is one of the key LEED credits for concrete products. The two opportunities for concrete masonry under this credit are the use of recycled materials as aggregate replacements and as cement alternatives.

However, by using the prescriptive requirements under the LEED Canada document, **Concrete Masonry is effectively prevented from qualifying for this credit where cement alternatives are proposed for use.** The requirements are based on ready-mix concrete mix design and manufacturing practices that do not adequately represent those of concrete masonry units. This document details an **alternative means recognized by LEED Canada that may now be used by the producers of concrete masonry units to qualify for the credit with the use of cement alternatives.**

Recycled Content Credit:

The LEED Recycled Content Credit is intended to encourage the replacement of raw materials with waste materials that would otherwise go to landfills. There are two categories of recycled materials under this credit: Post-Consumer and Post-Industrial ("Pre-Consumer" in future editions). Aggregate replacements could include Post-Consumer products such as recycled glass or recycled building demolition waste. They could also include Post-Industrial recycled materials that have not passed through the consumer waste stream, but are waste products from manufacturing processes. While there are a multitude of potential recycled materials, they must be carefully evaluated to determine if they are suitable for the manufacture, construction and long term serviceability of concrete block.

Supplementary Cementing Materials (SCMs) are being used widely as a replacement for part of the cement content in concrete products such as concrete masonry units. One unavoidable byproduct of the production of cement is CO_2, a greenhouse gas. The primary SCMs in current use are fly ash, a waste product from coal-burning electrical plants, and ground granulated blast furnace slag (GGBFS) from the steel making industry. Fly ash and GGBFS SCMs

fall under the Post-Industrial category, and are therefore given only half the rating of Post-Consumer materials (Post-Consumer is apparently encouraged to change consumer behaviour).

The positive effects of SCM substitutions are given a very high weighting in LEED Canada because of their double benefit of reducing cement requirements while utilizing a waste material. The LEED Canada credit applies a multiplier of 2 to the reduction in cement content between the mix with SCMs and a base mix without SCMs. This Cement Reduction Factor is not applied to the cement only, but rather, to the entire concrete product. The combination of these two factors can result in a **20-fold** increase in the impact for SCMs in concrete block, compared to what it would be if applied solely to the percentage of recycled content.

The recycled content from SCMs and/or aggregate replacements in concrete block is reported by the block producer and masonry contractor, and is subsequently entered by the design consultant into a LEED table showing the total recycled content of all the materials on the project - no one product qualifies for a LEED credit. The use of concrete block can provide a substantial contribution to a project's total Recycled Content credit.

Concrete Block SCM Issue:

The existing LEED Canada credit MR4 for Recycled Content addresses the use of SCMs in concrete by comparing the actual cement content in a product to a pre-defined **Base Mix**. The Base Mix formula used for the calculation is based on typical ready-mix concrete for cast-in-place applications, and although this formula works well for ready-mix concrete, recent MIBC/CCMPA research shows that **it does not work for concrete block.**

This formula defines the Base Mix (kg/m^3) as 10 times the compressive strength in MPa (25 MPa = 250 kg/ m^3 cement) for non-air entrained mixes. In 2005, in cooperation with the Canadian Concrete Masonry Producers Association (CCMPA), the Masonry Institute of B.C. (MIBC) carried-out a survey and study of strengths and mix designs used by block producers across Canada. When considering all block strengths, densities, and manufacturing methods, the results of the study confirmed that there is not a good fit between actual block mix designs and those calculated by the LEED formula, and further, that there is no simple, comparable, alternative formula.

The reasons that the ready-mix Base Mix formula does not work for dry-cast concrete block are related to the differences in mix design and manufacturing practices between concrete block and ready-mix concrete. Specifically, concrete block units:

- have significantly lower water content (zero slump);
- are formed in various types of block machines;
- are cured by a variety of different systems;
- utilize various types and densities of aggregates;
- are normally supplied to meet a lower minimum strength (15 MPa);
- have lower cement ratios, and because of the variables above, use cement contents that vary widely from plant to plant ;
- are batched using cement contents based on weight percentage rather than kg/m^3 (we don't manufacture cubic metres of block).

The result is that the use of SCMs in normal strength concrete block will not contribute towards the credit if the (ready-mix) Base Mix formula is used. However, in some cases, higher strength block will have lower cement contents than those calculated by the existing Base Mix formula and therefore could theoretically contribute to the credit without using SCMs.

Concrete Block SCM Solution:

Fortunately, there is a process under LEED Canada to address the various issues that are likely to arise when a standard is applied to a wide variety of real world buildings, or when new requirements are introduced. This process utilizes a **Credit Interpretation Request (CIR)** to make a submission for a LEED clarification to the CaGBC. This is not permitted on a cross-the-board basis, and must be submitted on a specific project to create a precedent.

To assist in the development of a CIR, the MIBC hired a consultant[1] who had experience with the development of the LEED SCM Recycled Content credit, and identified an appropriate project with an architectural firm[2] that was interested and willing to make the submission.

Our industry's solution is to simply report the amount of cement replaced by SCMs without the use of a Base Mix formula. This is similar to the simple calculation used for most other building materials, including the calculation for recycled aggregate in concrete block. A CIR that outlined this solution was submitted in August 2006, and approved by the CaGBC the following October. It is now posted on the CaGBC Web site as CIR #68.

Requirements for Block Producers:

The approved CIR outlines the revised requirements that block producers must meet to take advantage of the revised procedure. The basic change to the prescribed LEED SCM calculation method is to simply replace the comparison to the Base Mix formula with a calculation that is based on the actual cement contents used by the block producer for mixes with, and without, SCMs. This calculation effectively compares the weight of cement that has been replaced through the use of SCMs to the weight of cement that would otherwise be used to produce a concrete block having the same compressive strength without SCMs. Note that cement content reduction is used as the basis, and not SCM content. As shown in Example 1 below, the result of this calculation to establish cement weight reduction, along with an additional calculation to determine the Cement Reduction Factor, can now be submitted either by a letter from the block producer, or by completing project specific forms from the designer or general contractor.

The simple Block Calculator Tool, available on the MIBC and CCMPA Web sites and illustrated in Example 2, can also be used by the block producer to calculate the Cement Reduction Factor for concrete block, and to assist the producer in providing supporting data in an acceptable and consistent manner. The producer simply inputs the cement content percentages by weight of the non-SCM and SCM mixes for the specified block strength, and the Tool will calculate the cement decrease percentage and the Cement Reduction Factor. If more than one block type/strength is specified for a project, the quantity of (200 mm) equivalents and the cement contents for each block type are entered, and the Tool will calculate the weighted average cement decrease and the Cement Reduction Factor. The maximum initial cement content permitted in the calculation for a non-SCM mix under the CIR is 15%.

Note that the actual cement decrease percentage is **multiplied by two to obtain the Cement Reduction Factor**. This value is reported by the block producer and masonry contractor. It is then used by the designer to add the Concrete Block contribution to the "Post-Industrial" recycled content to that of all the other materials in the total project. For this calculation, the cost of all the materials being supplied is required, including that of the concrete block. The only other supporting documentation required by the concrete block producer is compressive strength test data (on file) to demonstrate and verify that the SCM and non-SCM mixes are comparable, and that both yield the same specified compressive strength.
The block producer and mason must then ensure that the proper units are shipped and installed.

As discussed earlier, there may be Post-Industrial or Post-Consumer recycled content from **aggregate replacement** that would apply under this credit. This content would be calculated as a percentage of the weight of the total block mix, and reported under the appropriate category. Therefore there are three possible recycled contents to calculate and submit:

1. Cement Reduction Factor from SCMs – Post-Industrial category
2. Aggregate Replacement percentage – Post-Industrial category
3. Aggregate Replacement percentage – Post-Consumer category

Example 1: Calculation of Aggregate Replacement and Cement Reduction Factor (single block type with single compressive strength)

Material	**Non-SCM Mix** (kg)	**(Weight %)**	**SCM Mix** (kg)	**(Weight %)**
Cement	225	9.68%	175	7.49%
SCM (slag, fly ash)	0		60	
Fine Aggregate	900		900	
Coarse Aggregate	700		700	
Recycled Aggregate	500	21.51%	500	21.41%
Total Weight	2325		2335	

Recycled Aggregate Content Percentage:

For the SCM mix case, the 21.4% value would be submitted as either Post-Industrial or Post-Consumer recycled content, depending on the specific aggregate used for the block on the project.

Cement Reduction with SCMs:

Cement Decrease percentage with SCMs:

$$\frac{\text{Non-SCM Cement \% - SCM Cement \%}}{\text{Non-SCM Cement \%}} = \frac{9.68 - 7.49}{9.68} = 22.6\ \%$$

Cement Reduction Factor = 22.6 % x 2 = 45.2 %

The **45.2%** number would be submitted as the recycled content percentage from cement replacement by SCMs under the Post-Industrial category for the block on the project.

In lieu of performing hand-calculations, the Concrete Block Calculator Tool may be used, as shown below. It is particularly useful when more than one block strength or type is used on a project. For example, the cement decrease percentage from Example 1, including the quantity of block having this strength or type, is entered in the first line of Example 2 using the Tool below. Also entered are the quantities and cement decrease percentages for two additional blocks having different strengths on the project. Block quantities are reported as 200 mm equivalents. The tool automatically calculates the weighted average cement decrease percentage and the Cement Reduction Factor. If the

Tool is not used, alternatively, the weighted average cement decrease must be calculated "by hand".

Example 2: Calculation of Cement Reduction Factor Using the Concrete Block Calculator Tool (multiple compressive strength example)

Concrete Block Calculator Tool:

LEED Canada MR Credits 4.1- 4.2: Recycled Content
- Calculation of Post-Industrial Recycled Content for SCMs Replacing Cement in Concrete Block

For each Mix Type Number, enter:
- Number of Units in 200 mm equivalents,
- Specified Strength (and mix type if same strength, i.e., different weights, colours)
- Cement % by weight in Non-SCM Base Mix,
- Cement % in SCM mix used. (i.e., fill in the empty "white" cells)
The Tool will calculate the cement decrease for each mix (%), the weighted average cement decrease (%), and the Total Cement Reduction Factor that is to be submitted for the block on the project.

Mix No.	Number of Blocks (200mm Equiv)	Specified Block Strength (MPa)	Non-SCM Base Mix: (Cement %)	SCM Mix (Cement %)	Cement Decrease %
1	25,000	15	9.68	7.49	22.62
2	30,000	20	11.00	9.16	16.73
3	10,000	25	12.50	12.50	0.00

Weighted Average Cement Decrease (%)	**16.42**
Total Cement Reduction Factor (%) Note: this includes the multiplier of 2 Submit as Post-Industrial recycled content	**32.84**

A copy of this Excel file for use on your projects is available from the MIBC and CCMPA websites www.masonrybc.org and www.ccmpa.ca

For further information on SCMs in concrete block or other "Green" issues contact:
Masonry Institute of B.C. (MIBC)
Bill McEwen, P.Eng., LEED AP, Executive Director
604-291-1458 info@masonrybc.org
Or
Canadian Concrete Masonry Producers Association (CCMPA)
1-888-495-7497 info@ccmpa.ca

1. Diana Klein, Eco-Integration Sustainable Design Consulting
2. Busby Perkins+Will Architects

Further information on Sustainable Design with Masonry:

The credits in LEED Canada that apply to masonry have been outlined in detail in the 110-page "Guide to Sustainable Design with Concrete" issued by the Cement Association of Canada - see www.cement.ca. A 4-page summary of masonry LEED credits is provided in a brochure from Masonry Canada entitled "How Masonry can Contribute to LEED and Sustainability", available from the Canadian Concrete Masonry Producers Association.

Summary of Masonry LEED Credits:

EA1 - Optimize Energy

- Thermal Mass from exposed exterior and interior masonry walls absorbs and releases heat slowly, which moderates temperatures to reduce heating and cooling loads, energy consumption, and equipment size.

MR1 – Building Reuse

- Older masonry buildings can provide required durability.

MR2 – Construction Waste Management

- Modularity of masonry minimizes waste.
- Demolition & construction masonry waste can be crushed & recycled.

MR3 – Resource Reuse (salvage)

- New masonry wall systems can be constructed with salvaged brick.

MR4 – Recycled Content

- Major contribution from the use of fly ash or slag as partial cement replacements in concrete products.
- Recycled materials can replace aggregates in brick & block.

MR5 - Local/Regional Materials

- Brick and block are usually available within 800 km shipping radius.

MR8 - Durable Building

- Masonry is a proven material for the durability credit based on Demonstrated Effectiveness.

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