

Calculating LEED Credits for the Recycled Material Content of Ready Mixed Concrete

Given the significant public and government support for sustainable development initiatives, RMCAO is receiving an ever increasing number of requests for additional technical information regarding the significant sustainable development properties of ready mixed concrete.

Along with the movement towards selecting highly sustainable construction products such as concrete, there also has been a significant increase in the specification of LEED certification for construction projects. The Canada Green Building Council (CaGBC) has therefore developed an extensive number of tools to allow the construction industry to quantify the sustainable benefits of their products.

LEED Concrete Certification

The CaGBC and EcoSmart Foundation, in conjunction with the Canadian Ready-Mixed Concrete Association (CRMCA), have developed a simple [Excel spreadsheet](#) to perform the necessary calculations that must be submitted by the firm applying for LEED's certification. This is to assist the ready mixed concrete industry in determining the recycled material content of the supplementary cementing materials (SCM) used in the concrete mix.

As it currently stands, the project can receive either one or two LEED credits for the use of recycled materials in the project (this includes all construction materials and is not just limited to ready mixed concrete). In order to obtain one credit the owner must first demonstrate that at least 7.5% post-consumer and post-industrial recycled materials have been used in the project. To obtain the second credit the owner must increase this replacement level to at least 15%.

Ready mixed concrete contributes to the recycled materials content in the LEED rating system by focusing on replacing the amount of cement in the mix design with the increased use of SCM's, such as slag and fly ash. While the calculations for the recycled content percentage within each material is done by weight, the calculation of the total recycled material content percentage is done on a cost basis.

LEED Concrete Calculations

In the LEED system, the SCM percentage is calculated in terms of the **amount of Portland cement replaced rather than the actual amount of SCM's used**. In this system the anticipated quantity of Type GU (10) cement is determined based on the specified compressive strength, and if the concrete contains air entrainment or not.

The base cement content of each concrete mix design is therefore calculated as follows:

$$\text{Base Cement Content (kg/m}^3\text{)} = \text{Compressive Strength (MPa)} \times K$$

Where K is equal to:

- 10 for non air entrained concrete
- 12.5 for air entrained concrete

For example, if the owner has specified 30 MPa, non-air entrained concrete for all interior concrete columns in a building, the base cement content for the mix design would be = $30 \times 10 = 300 \text{ kg/m}^3$. The concrete producer in this situation should therefore **attempt** to produce a concrete mix design utilizing less than 300 kg/m^3 of Type GU (10) cement in order to obtain the largest possible credit. A 30 MPa, 330 kg/m^3 mix design utilizing 30% slag replacement would result in an actual Type GU (10) cement usage of $330 \times 0.70 = 231 \text{ kg/m}^3$. This represents a 69 kg/m^3 ($300 - 231$) reduction in cement consumption.



Please note that there are many instances where either the project specification requirements or contractor/project constructability issues will prevent the concrete producer from achieving this goal. For example, accelerated concrete mix designs that provide 75% of the specified compressive strength in 24 hours will often exceed the target base cement content.

In order to streamline the calculation process and to minimize the potential for any data entry errors, a simple Excel spreadsheet can be utilized to complete all the necessary calculations. This program is available from the CaGBC website and has been uploaded to the RMCAO website for your use as well.

CaGBC and RMCAO's Concrete Mix Design Policy

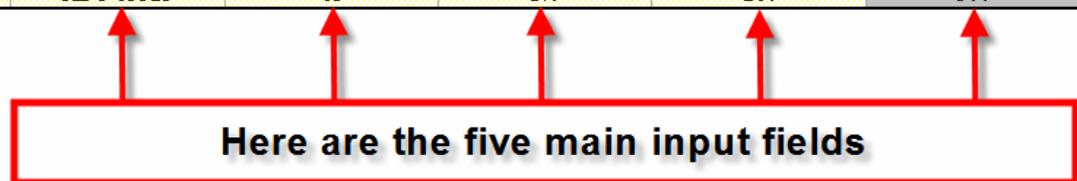
The CaGBC has formally recognized the concrete industry's need to protect the proprietary information included in our concrete mix designs. At the same time the concrete industry recognizes the need for the design consultant to be able to quantify the amount of recycled material actually used in the production of concrete. Since the calculations required to determine the total percentages of recycled material used in concrete require specific knowledge of the exact Type GU (10) cement content of the mix, the EcoSmart Foundation developed a concrete calculator tool that can be directly used by the concrete producer. The final results of the calculations are then supplied to the contractor and the design consultant without having to disclose any proprietary mix design information. The concrete producer completes the necessary calculations and then submits a letter to the contractor indicating the actual replacement levels for the project (see [RMCAO sample letter](#)).

How to Use the EcoSmart Foundation SCM Calculator Spreadsheet

Utilization of the EcoSmart Foundation Excel spreadsheet is relatively straight forward once you have collected all the necessary information. The basic steps to completing this process are as follows:

1. Identify all the concrete mix designs that were supplied to the project
2. List the specified compressive strength requirement (MPa) for each mix design and identify if the mix contained air entrainment
3. Determine the exact quantities of concrete supplied for each mix design
4. Determine the actual Type GU (10) cement content for each concrete mix design

<i>Application</i>	<i>Mix Design Code</i>	<i>Specified Strength (MPa @ 28 Days)</i>	<i>Air Entrainment (Yes/No)</i>	<i>Type GU (10) Cement (kg/m³)</i>	<i>Total Quantity (m³)</i>
<i>Slab on Grade & Suspended Slabs</i>	ABC 25347	25	No	240	7,000
<i>Parking Garage</i>	ABC 35341	35	Yes	350	2,000
<i>Foundation Walls</i>	ABC 20335	20	Yes	240	1,500
<i>Exterior Flatwork</i>	ABC 32349	32	Yes	335	1,000
<i>Interior Columns</i>	ABC 50345	50	No	410	1,000
<i>Footings</i>	ABC 15325	15	No	210	300



5. Enter this information into the EcoSmart Foundation spreadsheet (see sample below).

MR Credits 4.1 - 4.2: Recycled Content - Calculations for Post-Industrial Recycled Content for SCMs in Concrete

Calculation of %Post-Industrial Recycled Content of Concrete Containing SCMs to Partially Calculation of Total Cost of Concrete

Enter the Mix No., Concrete Design Strength, whether concrete is Air-Entrained, actual Portland Cement Enter the Materials Cost of Concrete and the

Mix No.	Concrete Design Strength @28d (MPa)	Air-Entrained (Y/N)	Base Portland Cement (kg/m ³)	Portland Cement Used (kg/m ³)	Volume of Mix (m ³)	Cost Type	Cost (\$)
ABC 25347	25	n	250	240	7000	Materials Cost of Concrete	
ABC 35341	35	y	438	350	2000	Cost of Form Materials	
ABC 20335	20	y	250	240	1500		
ABC 32349	32	y	400	335	1000		
ABC 50345	50	n	500	410	1000		
ABC 15325	15	n	150	210	300		
Total % Post-Industrial Recycled Content:							15.04

- Record the Total % Post-Industrial Recycled Material Content for the project
- Issue a summary letter to your customer (typically the contractor) indicating the total quantity of concrete supplied to the project and the Total % Post-Industrial Recycled Content as calculated by the spreadsheet.

Tips Regarding Data Entry in the SCM Concrete Calculator

The concrete producer should keep in mind the following points when performing the data entry and completing this submission:

- The calculator currently only accepts a maximum of 20 mix designs. RMCAO has requested that the spreadsheet be expanded to allow for up to 50 mix designs but the user cannot make this change since the spreadsheet has been locked and password protected. If your project contains more than 20 mix designs you can prioritize them by the total quantity of concrete supplied and enter the data starting with the largest to smallest quantities. You should then indicate in your submission letter the fact that all mix designs couldn't be entered and indicate the percentage of concrete included in the calculations.
- The **first mix design entered must contain a cement reduction** or the spreadsheet will not function correctly and will show a "**Zero**" percentage recycled material content.
- If you have mix designs that result in a **negative Portland cement reduction**, it may be more advantageous for the Project Team pursuing LEED Certification **to eliminate those mix designs from the recycled content and cost calculations**. The LEED credits are awarded for recycled content, as such there is no penalty for not having recycled content.
- The only two items to be submitted to your customer are the total quantity of concrete and the total % Post-Industrial Recycled Content. The material "cost of concrete" and "material cost of forms" should be supplied by the contractor directly to the design consultant. Please note that the concrete producer is under no obligation to identify their raw material costs to anyone and we would suggest that you contact RMCAO directly if you are receiving requests for your private financial information.
- Given the fact that the SCM calculator uses a theoretical base cement content system (based on strength and air entrainment as shown above) it is possible to show a cement content reduction without actually using any SCM materials at all. The LEED rating system assumes a baseline Type GU (10) cement content and then encourages the concrete producer to reduce the use of cement via any means. High quality aggregates, concrete admixtures and SCM's may all be viable solutions to reduce the cement content below the theoretical LEED's base cement content, while still achieving the necessary concrete performance requirements.

Electronic versions of the EcoSmart Foundation, SCM Calculator and a sample LEED certification letter can be obtained on the RMCAO website. If you have any further questions regarding LEED certification requirements, please contact Bart Kanters, RMCAO Director of Engineering.