

Guidance for Revising Concrete Specifications for EcoSmart™ Concrete

EcoSmart concrete is not a proprietary technology or a rigid formula; rather, it is a customer-friendly way of describing concrete that is optimized to achieve the least environmental impact with no adverse effect on construction schedule and costs, or on the quality and performance of the concrete.

The following clauses may be included in EcoSmart (cast-in-place) concrete specifications. Some of the suggested clauses have been used on a LEED® Silver project. Pre-cast concrete can likewise be manufactured using the EcoSmart concrete approach.

Disclaimer: The suggested clauses are for guidance only. An experienced professional structural engineer should review the complete concrete specification before it is used for construction. EcoSmart Foundation and other contributing authors do not guarantee any results on construction projects from using this guidance.

Acknowledgement: The following clauses have been prepared based on project specifications developed by Read Jones Christoffersen Ltd., a leading structural engineering firm experienced with the use of EcoSmart concrete.

In Section 03300 of the cast-in-place concrete specification, include:

In sub-section, **General – Description of Work Included**, add:

- The intent of this Specification is to require higher than normal amounts of supplementary cementing materials (SCMs) as a replacement for Portland cement.

In sub-section, **General – Reference Standards**, add:

- CAN/CSA A23.1-04, Concrete Materials and Methods of Concrete Construction
- CAN/CSA A3001-03, Cementitious Materials for Use in Concrete.

In sub-section, **General – Submittals**, add:

- Submit documentation of the recycled content of the concrete. For water, sand and aggregates, the recycled content should be expressed as the weight of recycled content of the material over the total weight of concrete constituents. For supplementary cementing materials (SCMs) such as fly ash, silica fume, and blast furnace slag, the recycled content should be expressed as the reduction of Portland cement from Base Mix to Actual SCM Mix (see sub-section Products – Materials). For all concrete constituents, the recycled content should be specified as post consumer or post industrial.
- Submit documentation of where the concrete constituents were extracted, processed and manufactured. Where possible, materials should be selected within an 800 km (500 mile) radius, or be shipped by rail or water from within 2400 km (1500 miles) of the project site.

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In sub-section, **Products – Materials**, add:

- The mix design shall take full advantage of the use of supplementary cementing materials (SCMs), such as fly ash, silica fume, and blast furnace slag, to reduce the cement content of the concrete.
- SCMs shall comply with CSA A3001. The following information should be submitted in a letter signed by the concrete supplier/manufacturer or professional engineer:
 - The reduction in Portland cement from Base Mix to Actual SCM Mix (as a percentage of Base Mix), where Base Mix is defined below. This can be submitted as a total reduction of Portland cement for all the concrete mixes used on the project.
 - Portland cement content of Base Mix (kg/m³) = Design strength values in MPa at 28 days x K
 where K = 10 for non-air-entrained concrete, or
 K = 12.5 for air-entrained concrete.
 - Portland cement reduction = (Portland cement content of Base Mix – Portland cement content of Actual SCM Mix) / Portland cement content of Base Mix
 - The following cement reduction percentages by element are to be used as a minimum on this project. These percentage reductions in cement should be achieved without affecting cost or schedule for the project

Note: The designer to adjust, add and delete elements and percentages to suit the project.

Element in Structure	Min. % Cement Reduction (>5°C ambient temp.)	Min. % Cement Reduction (<5°C ambient temp.)
Suspended Slabs and Slab Bands	25	20
Slab on Grade (interior parking)	25	20
Slab on Grade (no parking)	30	25
Slab on Grade (exterior)	15	10
Footings	50	45
Walls	45	40
Columns	45	40

- The concrete strengths noted on the structural drawings may be obtained in 56 days where the above cement reduction percentages >25% are achieved.

In sub-section, **Execution – Mix Designs**, add:

- Water-to-cementing materials ratios and air contents for exposure class shall be as per the Standard unless otherwise noted herein.
- At least 4 weeks prior to commencing work, Contractor shall inform Engineer of proposed source of aggregates and SCMs, and provide access for sampling.

In sub-section, **Execution – Trial Mixes**, add:

- Contractor shall submit a list of proposed locations for trial pours to be completed (e.g., in footing elements, in the basement level, or in a section of the parking slab on grade).
- Contractor shall conduct on-site trial pours with trial mixes of concrete that will be used in the following elements: columns, wall finish over a 5m x 5m area, slab floor, and soffit over a 5m x 5m area. The trial pours shall include finishing and curing methods to establish appropriate techniques and durations for the project. The following properties shall be evaluated in the trial: workability, air content, finishability, setting time, temperature development, hardened air-void parameters, strength and salt-scaling durability (as per modified ASTM.C672). Contractor shall repeat samples for any rejected work.

Note: The designer to list elements requiring trial mixes.

Note: The designer to list properties requiring evaluation.

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In sub-section, **Execution – Curing and Protection**, add:

- Cold and hot weather protection shall comply with the Standard or the requirements on the structural drawings, whichever are more rigorous.
- Concrete shall be cured in accordance with CSA A23.1.
- Contractor shall submit a plan for curing to the Owner, for review and approval together with other tender documents. The curing plan shall be prepared in strict accordance with clause 8.8.6.2 of CSA A23.1, including:
 - The method for protecting the concrete from evaporation of surface moisture from the fresh concrete
 - The type of curing material to be used.
 - How the surface will be kept moist and the quality control requirements for keeping the surface moist.
 - The time of initiation and duration of curing.
 - Provisions to address potential problems such as high winds, and hot and cold weather.
 - The limitations of access, if any, to the surfaces being cured.
- All concrete mixes proportioned for C-XL class of exposure shall have Extended Curing. Concrete mixes that meet the definition of HVSCM-1 and where classes of exposure C-1, A-1, F-1, S-1, and S-2 apply shall have Extended Curing. For other exposure classifications, concrete mixes that meet the definition of HVSCM-1 or 2 shall have Additional Curing.
 - $HVSCM-1 = FA/40 + S/45 > 1.00$
 - $HVSCM-2 = FA/30 + S/35 > 1.00$
where FA = fly ash (Type F, CI1, or CH content of the concrete (% mass of total cementing materials) and S = slag content of the concrete (% mass of total cementing materials)
 - Additional Curing = 7d at $\geq 10^{\circ}$ C for a time necessary to attain 70% of the specified strength. When using silica fume concrete, additional curing procedures shall be used. See Annex I, Clause 1.3.13 of CSA A23.1.
 - Extended Curing = A wet-curing period of 7d. The curing types allowed are ponding, continuous sprinkling, absorptive mat, or fabric kept continuously wet.
- Contractor shall obtain the approval of the Owner, for proposed means of monitoring concrete curing conditions. Contractor shall be responsible for confirming completion of curing.
- Curing for concrete will be considered as consisting of 10% of the total unit price per cubic metre of concrete bid. Contractor shall provide verification in the Quality Control Plan that concrete has been cured in accordance with the Specifications to receive this portion of concrete payment. Payment for curing will also include all costs for containment and drainage for curing water and ensuring water does not fall on adjacent roadways or shoulders or impede traffic movement in any way.