Supplementary Cementing Materials Standards and Guidelines

Climate Change, EcoSmart Concrete Technology and Green Building

Toronto, March 4, 2004

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Why Use SCMs in Concrete for Green Buildings?

- Replacing a portion of the cement in concrete with a SCM significantly reduces the embodied energy (GHG) associated with concrete
- If not used in cement and concrete, most SCMs would still be produced and occupy space in landfills
- Clinker content of cementitious product in concrete was 91% in 1990. By 2010 it is projected to fall to 84%.
- By 2010, SCM use in Canada is projected to increase 8.3% over 1990 levels

SCMs make better, more durable, more sustainable concrete

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What SCMs are Available in Ontario ?

- Slag Cement (Type S)
- Fly Ash (Type CI)
- Slag/Fly Ash blend
- Silica Fume Cement (Type 10E-SF)

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How do SCMs Effect Plastic Concrete ?

- Plastic properties
  - Pumpability
  - Workability/Placeability
- Setting times
- Finishing Times

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Hardened Properties of SCM Concrete

- Early Strengths
- Ultimate Strengths
- Permeability and Durability
  - Resistance to chloride intrusion
  - Resistance to most forms of degradation
  - Salt Scaling

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Royal Bank Tower, Toronto 1973

20% Fly Ash

55 MPa Spec

Strengths as high as 70 MPa

CSA A23.1-00

- There are currently no limits or guidance on High Volume Supplementary Cementing Material (HVSCM) concrete in CSA A23.1 "Concrete Material and Methods of Concrete Construction"
- The draft version intended to be issued in January 2005 contains a section on HVSCM concrete.

Current Practices for the use of SCMs in Concrete in Ontario

- SCMs are used in most of the concrete produced in Ontario - although not usually at high levels
- Slag
  - 0 to 35%
  - The higher the total cementitious content the higher the % of Slag
  - The lower the temperature the less Slag is used
- Fly Ash
  - 0 to 30%
  - Similar to Slag, but lower replacement rates
  - Some specialty mixes such as mining backfill can use up to 95% SCMs
- Mix Designs are already optimized for the cementitious system used.

Proposed CSA A23.1 Requirements for High Volume SCM Concrete (clause 27.7.1.1)

- **Definition - High-Volume Supplementary Cementing Materials Concrete** (HVSCM)
  - **"…contains a level of SCM above that typically used in normal construction"**
- Two categories of HVSCM are defined:
  - ***HVSCM-1*: FA/40 + S/45 > 1**
  - ***HVSCM-2*: FA/30 + S/35 > 1**
- The new CSA A23.1 should be published in ***January 2005***

HVSCM Concrete – Reduced W/C

- 27.7.3 Requirements for C, F, S, R and A Classes of Exposure
  - The maximum water-to-cementing materials ratio of the concrete should meet the limits in Table 14, except when the concrete is exposed to freezing and thawing in which case the values in Table 14 shall be ***reduced by 0.05 for HVSCM-1***.
    - Note: example for C-1 Exposure the maximum water-to-cementing materials ratio in Table 14 is 0.40, but for HVSCM-1 concrete this maximum value shall be reduced to 0.35.

HVSCM Concrete – Reduced W/C

- The minimum specified ***28d compressive strength*** requirements in Table 14 shall be specified at ***56 days*** for HVSCM-1 concrete.

HVSCM Concrete – Maximum W/C

- 27.7.4 Requirements for reinforced concrete
  - For
    - reinforced concrete elements
    - exposed to moisture and air
    - with depths of cover less than 50 mm
  - the water-to-cementing material ratio should be
    - not greater than 0.45 for HVSCM-2 concrete
    - and not greater than 0.40 for HVSCM-1 concrete.
  - Note: this clause is intended to minimize the risk of corrosion of embedded steel due to carbonation of the concrete cover.

HVSCM Concrete – Curing

- 27.7.6 Curing Requirements
  - The curing and protection requirements of
    - Curing Regime 2 shall be implemented for HVSCM-2 and
    - Curing regime 3 for HVSCM-1.

Proposed CSA A23.1 Curing Categories

- 1 Basic
  - 3 d at ≥ 10oC or for a time necessary to attain 40% of the specified strength.
- 2 Additional
  - ***7 d at ≥ 10oC and*** for a time necessary to attain ***70% of the specified strength***. When using silica fume concrete additional curing procedures shall be used. See Appendix J, section 3.12.
- 3 Extended
  - A ***wet-curing*** period of 7 days. The curing types allowed are ponding, continuous sprinkling, absorptive mat or fabric kept continuously wet, forms in contact with the concrete surface, a sealed plastic envelope in contact with the concrete surface

How to Successfully Use SCMs in Concrete

- ***Work with contractors and suppliers to to determine what will work!***
- ***Do not use higher SCM levels than construction procedures and durability requirements dictate***
- ***One failed project can overshadow 100 successful projects***
  - Salt scaling resistance, carbonation, short and long term strengths and durability are the main restrictions
  - More research and field experience is required to develop the field procedures to increase current SCM maximum replacement rates
- ***The big gains in SCM use are in using them in all concrete not in using too much in any one project.***

How to Successfully Use SCMs in Concrete

- ***Address Construction Site Requirements***
  - Extended curing for slow strength gain mixes
  - Construction schedule may be extended…….
  - Initial protection period for mixes that do not bleed
  - Adjust mixes to ensure adequate finishability
  - Pre-pour meetings and site crew training if mixes are appreciably different from normal
- *Mock ups and trial pours to demonstrate constructability and appearance - may be prudent for large projects*

How Much SCM Should be Used

- ***Use a replacement rate that is consistent with the requirements for,***
  - Construction efficiency,
  - Long term proven durability
  - And all other performance requirements of the structure.

What Can You Do Today to Make Development More Sustainable ?

- Design for Sustainability from the beginning, the concept stage.
- Design for energy efficiency and low maintenance
  - Design to let concrete's thermal mass work for you for ever
  - Use Insulated Concrete Forms
  - Reduce your lighting to account for concrete reflectance
- Specify Concrete rather than materials with higher environmental impact
- Take advantage of the multiple environmental benefits of designing with concrete
  - No emissions
  - Low maintenance
  - Durability
  - etc.

What Can You Do Today to Make Development More Sustainable ?

- High Performance Cements and Concrete can reduce the amount of Cementitious materials and total volume of concrete required
- Use of the highest "practical" % of SCMs
  - Ensure that the required quality control and other construction implications of the use of high SCM concrete are addressed.

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