
Supplementary Cementing Materials (SCMs)
A Concrete Producer's Perspective
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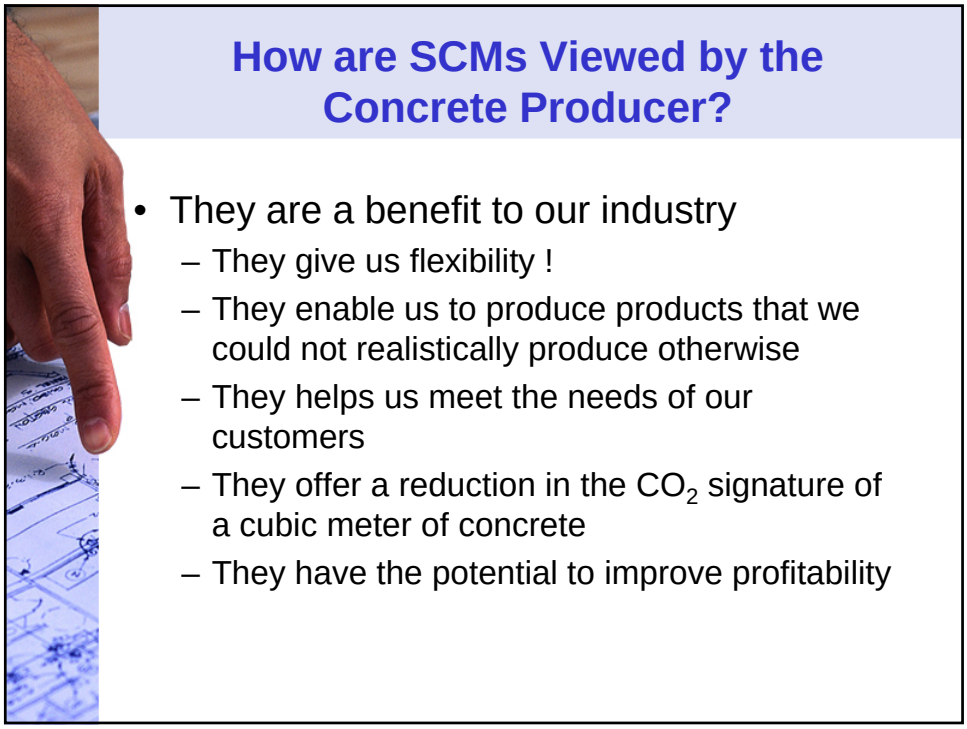
How are SCMs Viewed by the Concrete Producer?
• They are a benefit to our industry
– They give us flexibility !
– They enable us to produce products that we could not realistically produce otherwise
– They helps us meet the needs of our customers
– They offer a reduction in the CO_2 signature of a cubic meter of concrete
– They have the potential to improve profitability

SCMs bring to concrete performance:

- Increased ultimate strength
- Extended set times
- Superior sulfate resistant
- Decreased permeability
- Mitigation of alkali aggregate reaction
- Improved resistance to chemical corrosives
- Improved abrasion resistance
- Improved workability
  - Improved finishability
  - Improved pumpability

Issues

- Limited storage capacity
- Variability in product
- Limited availability
  - Slag
  - Class C flyash
- Uninformed consumers
- Over promotion
- Over selling
- Non-standard Specifications

Issues

- **Variability in colour**
- **Delayed Finishing**
  - Increased manpower costs
    - could be an advantage in hot weather, increased working time
- **Low Early Strength**
  - Delayed form turn over
    - extended construction schedule

Concrete Producers need to be concerned with:

- Operating outside of typical substitution levels:
  - Replacement levels **well** beyond personal or local industry experience
  - Materials we are not familiar with
    - Different type &/or source
    - Combinations of SCMs beyond personal or local industry experience.
- responsibility for performance issues from specified SCMs

Concrete Producers need to be concerned with:

- The level of expertise or experience of all the project partners:
  - Structural designers and engineers
  - Consulting engineers
  - Inspecting Engineers
  - Owners
  - Contractors
    - Formworkers
    - Concrete placing and finishing crews
- The experience and education of concrete delivery personnel

SCMs in Atlantic Canada

- There are 2 SCMs available
- Class “F” fly ash
- Silica Fume

Quality Concrete first began using fly ash in 1985

Our replacement levels were from 10 to 15 %

Fly ash was viewed as a waste product and generally frowned upon by the consumer and contractor.

Fly ash was used initially as a cost saving measure.

Over time the benefits of delayed set, workability, pumpability and AAR mitigation became principle reasons for use. Replacement range went to 15 – 20 percent.

SCMs in Atlantic Canada

Silica Fume

- Silica fume has been used in Atlantic for the past 18 years.
- Initially in a bagged form
- Available as a blended or inter-ground product from cement suppliers in Atlantic for the past 15 years.
- Silica fume has be used in marine, high performance concrete and shotcrete.

SCMs in Atlantic Canada

Silica Fume

- For high performance concrete silica fume and class F fly ash combined in a ternary blend give optimum concrete performance
- Silica fume enhanced concrete will deliver strength and durability however water cement ratio must be respected.
- Strengths obtained using silica fume may entice a reduction of cement content. For durable concretes using silica fume, Superplasticizing admixtures are a must.

Future use of SCMs

- CSA – A23.1- 2004 edition

•Revisions and reclassifications in this document will facilitate the specification of SCMs in concrete.

Future use of SCMs

- Performance specifications incorporating SCMs and high volume SCMs are attainable through the revisions in the standard.

❖Specifiers need only state the level of SCM desired to include a SCM in a given class of concrete.

❖HVSCM-1

❖HVSCM-2

❖ Specifiers and concrete producers must be mindful of the requirement for changes in water cement ratio and extension to 56 day strengths for HVSCM-1

Annex K in the CSA Document gives non-mandatory recommendations on the interpretation of the proportioning of SCMs.

CSA Recognized Cementing Materials

- **Portland Cement** (subject to exposure)
  - Type GU (10)
  - Type HE, high early strength (30)
  - Type MH (20) or LH (40) for low heat
  - Type MS (20) or HS (50) for sulphate resistance
- **Blended Cements**
- **SCMs**
  - Type S (GGBFS, slag)
  - Type F, CI, CH (Fly ash)
  - Type SF (Silica Fume)

Concrete production and SCMs

- Finding the boundaries
  - When concrete with SCM, and in particular HVSCM, are discussed the comparison in performance relates back to normal Portland concrete.
  - For success and acceptance in the field there needs to be some data for comparison
  - Because the variables that influence the plastic state of concrete vary by the day or even the hour it is extremely difficult to predict the plastic performance of concrete containing SCMs and HVSCM -1or -2.

Concrete production and SCMs

Specification deficiencies

- If the specification is poorly written the entire project starts off on the wrong note.

Specification Deficiencies

Proportion normal density concrete in accordance with CSA-A23.1, Alternative 1. to give the following properties for concrete grout in masonry walls:

.1 Use type 10 cement.
.2 Minimum replacement of cement with fly ash is 40%.
.3 Minimum compressive strength at 28 days: 20 MPa.
.4 Class of exposure: N.
.5 Nominal size of coarse aggregate: 10 mm.
.6 Slump at time and point of discharge: 150 mm maximum.
.7 Air content: 3%.
.8 Chemical admixtures: type as approved and in accordance with ASTM C494.
.9 Use of superplasticizers is permitted to allow ease of placement of concrete. 150 mm maximum sump is maximum prior to addition of superplasticizer.

Specification Deficiencies

Proportion normal density concrete in accordance with CSA-A23.1, Alternative 1, to give the following properties for concrete in mud slabs:

.1 Use type 10 cement.
.2 Minimum replacement of cement with fly ash is 40%.
.3 Minimum compressive strength at 28 days: 15 MPa.
.4 Class of exposure: N.
.5 Nominal size of coarse aggregate: 20 mm.
.6 Slump at time and point of discharge: 80 mm ± 30 mm maximum.
.7 Maximum air content: 3%, maximum.
.8 Chemical admixtures: type as approved and in accordance with ASTM C494.

Testing and Inspection

- Cement replacement levels above 25% require detailed attention to sampling and cylinder storage.
- Reduced portland cement contents mean lower reported strengths at 7 days.
- Our current rules of thumb for strength gain in cylinders are becoming obsolete.
- Initial curing conditions become critical
- Less experienced inspection agencies are quick to raise false alarms when strengths are outside our experience with normal portland.

All inspection must be performed with strict adherence to CSA

Projects requiring SCM

REMEMBER

- Find the objectives the specification is trying to achieve:
  - Are the objectives achievable?
  - Are there strength targets from the SCM usage?
  - Are there recycling or GHG reduction targets (Leed, Green Building)?
  - Are there heat of hydration, aggregate quality or architectural issues?
- Secure a source of the SCMs required
- Determine the delivery method of the SCM into the mixture
  - Blended cement vs. individual component

Projects requiring SCM

- Review the list of industry partners
  - Are they experienced?
  - Do they understand the specification from a performance perspective?
  - Does the contractor understand the changes to the plastic concrete?
  - Is the inspection agency experienced in evaluating performance of SCM concretes?
  - Maintain as much flexibility as possible.
- Start dialog early with the contractor and project partners (Pre-construction meeting)

Projects requiring SCM

- Be clear regarding limitations in solving plastic performance issues that will potentially arise
  - Extended set times
  - Cold weather
  - Hot weather
  - Plastic shrinkage or delaminating surface
  - Increased form pressures
  - Variability in entrained air
- Do not forget about constructability issues
  - Recognize you may be between the contractor and profitability
  - Recognize limitations in neutralizing issues arising from SCM usage
    - Set acceleration techniques will be less effective for SCM mixes
    - Environmental effects are exaggerated in SCM placements (hot, cold, dry, windy)

Finally ……..

- Specifications determine Performance
- Job specific specifications mean job specific performance
- Concrete Suppliers deliver specified performance
- Inspection measures performance relative to the specification
- Not all issues arising from specifications can be solved by the concrete mixture


Thank you