

**Specifier's Perspective**  
**Supplementary Cementing**  
**Materials on MTO Contracts**

CIRCA Collaborative Series  
London, March 10, 2005  
Toronto, March 11, 2005

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Ontario Ministry of Transportation



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**Supplementary Cementing**  
**Materials Used by MTO**

- Slag
- Fly ash
- Silica fume

• The products are evaluated, listed on MTO list of approved products (DSM), and monitored



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**Slag**  
(Ground Granulated Blast  
Furnace Slag)

A by-product of steel industry,

Local (Ontario) Sources: Stelco, Dofasco,  
Algoma



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## Fly Ash

A by-product of coal-fired power plants

Local (Ontario):  
Atikokan, Thunder Bay  
*Ontario Power Generation*

Imported:  
From Michigan, Wisconsin, Indiana, Illinois and Ohio  
*Detroit Edison, Wisconsin Public Service Corporation, Alliant Power,  
Indiana - Michigan Power, Midwest Generation EME and First  
Energy*

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## Silica Fume

- By-product of production of silicon, ferrosilicon, or other silicon containing alloy

### Sources:

-St. Laurent, Quebec (*Becancour Silicon*)  
-Niagara Falls, U.S.A (*Norchem*)

- Used in the form of blended cement

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## History and Current Use

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LABORATORY DIVISION  
 Highway Engineering Division,  
 Central Building.  
 Attention: \_\_\_\_\_  
 Our File No. \_\_\_\_\_  
 Subject: Slag Cement.

Room 313, Central Building.  
 Slag 1979-01-11  
 in R.R. to \_\_\_\_\_

RECEIVED  
 JAN 12 1979  
 PUBLIC ASSURANCE CO.

The Concrete Unit of the Materials & Laboratory Services Section of this office has investigated the possibility of using slag cement as partial substitution for Portland cement in concrete used by our Ministry. A report on testing, findings and conclusions has been prepared and was issued in November, 1978. A copy of the report is attached.

Based on the findings and conclusions the following recommendations are presented in the report:

"THAT THE USE OF THIS SLAG CEMENT BE ALLOWED ON A LIMITED NUMBER OF MTC CONTRACTS. THE MAXIMUM SLAG TO TOTAL CEMENT RATIO SHOULD NOT EXCEED 0.25 IN ANY CLASS OF CONCRETE."

FINAL APPROVAL OF THE CEMENT SHOULD BE SUBJECT TO ITS SATISFACTORY PERFORMANCE FOR AT LEAST TWO YEARS ON THESE CONTRACTS.

- First used in the late 1970s
- In 1979 allowed on a limited number of contracts
- On all MTO contracts since 1983
- In OPSS 1350 since 1995

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## Slag in MTO Work

- Up to 25% of slag is used in cast-in-place concrete. Today, in southern Ontario, slag is used in about 90% of cast-in-place concrete by MTO
- Up to 50% slag replacement can be used for sulphate resistance in foundations




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## Slag

- Up to 70% allowed in precast products such as catch basins or pipe




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## Special Considerations

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## Slag and Fly Ash

- used at the Contractor's option
- mix design submitted ; proportions, sources
- samples of cement, slag or fly ash provided
- placing, finishing, curing the same as portland cement concrete
- strength and air void system requirements; the same as portland cement concrete

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## Silica Fume

- Silica fume is specified for high performance concrete; structures
- Superplasticizer must be used
- Trial batches required
  - no segregation
  - no lumps
  - air, slump, temperature
  - compressive strength, RCP, AVS
  - workability, slump retention



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## Silica Fume



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## Silica Fume



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## Silica Fume

- Concrete temperature and gradient controlled
- End result specification for strength, AVS and RCP
- Strength on 100x200mm cylinders, sets of three
- Requirement for crack repair

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## Advantages to Using SCMs

Slag and fly ash improve workability



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# Advantages to Using SCMs

Slag, fly ash and silica fume enhance concrete by :

- Increased resistance to penetration of chlorides
- Reduced permeability
- Higher long term strength, continued strength gain
- Increased resistance to alkali-silica reaction

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## Limitations

### Severe Highway Environment



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## Scaling



- Typically a surface problem
- does not affect internal structure unless it is combined with poor air entrainment