# Specifier's Perspective Supplementary Cementing Materials on MTO Contracts

CIRCA Collaborative Series

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Ontario Ministry of Transportation

# Supplementary Cementing Materials Used by MTO

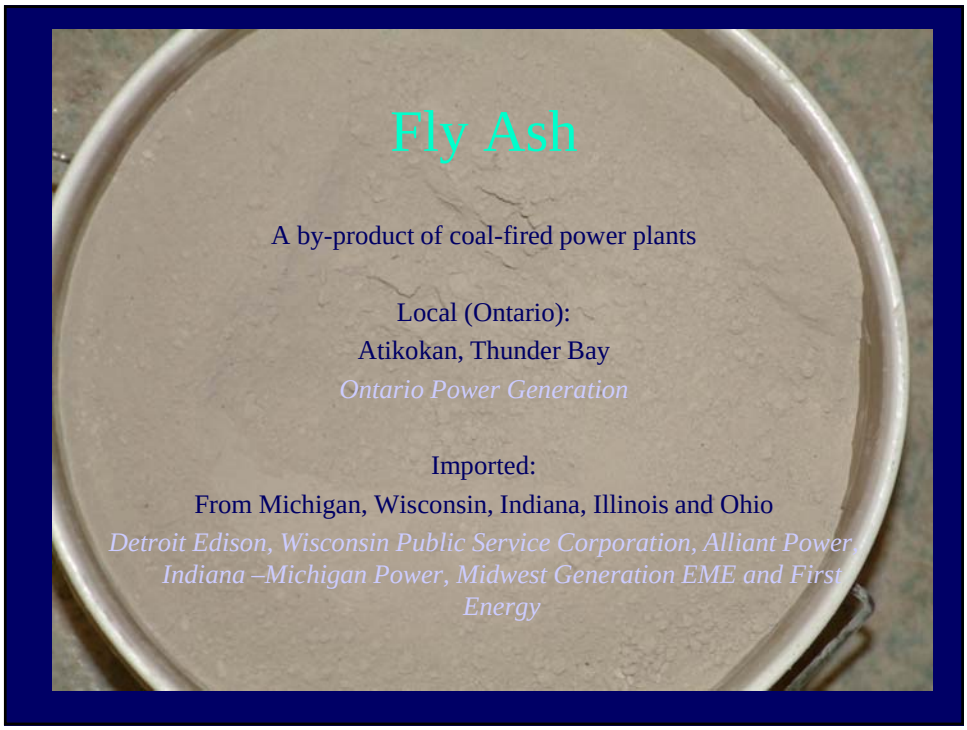
- Slag
- Fly ash
- Silica fume

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

# Slag
# (Ground Granulated Blast Furnace Slag)

A by-product of steel industry,

Local (Ontario) Sources: Stelco, Dofasco, Algoma

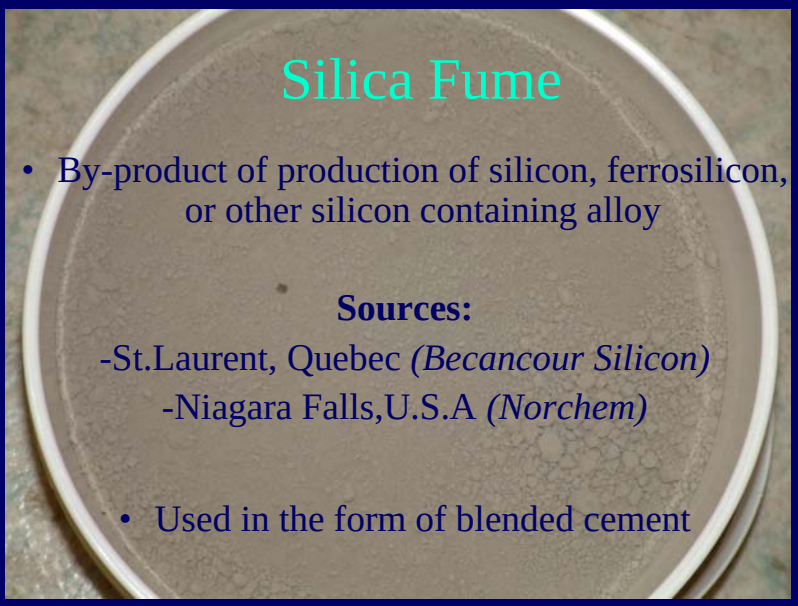


# Fly Ash

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*



## 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

## History and Current Use

## Slag

Executive Director,
Highway Engineering Division,
Central Building.

Room 313, Central Building.

Attention:

Our File Ref.

1979-01-11

In Reply to

RECEIVED
JAN 12 1979
QUALITY ASSURANCE SECTION

Subject: Slag Cement.

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.

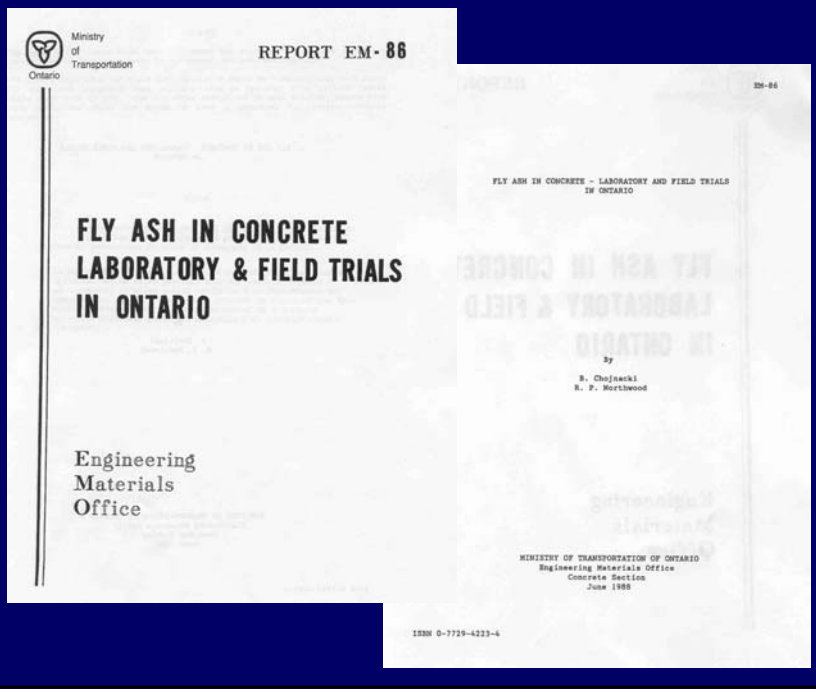
- First used in the late 1970s
- In 1979 allowed on a limited number of contracts
- On all MTO contracts since 1983
- In OPSS 1350 since 1995

## 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

# Slag

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



# Fly Ash

- Fly ash has been used by MTO since 1986
- Up to 10% of fly ash is allowed in cast-in-place conventional concrete
- Up to 25% of fly ash is allowed in high performance concrete
- Up to 40% fly ash is allowed in some precast products

# Silica Fume

- First used in SF overlay in 1992
- Silica fume, has been specified for production of high performance concrete since 1995
- About 8% replacement used; supplied pre-blended or interground with portland cement

## Special Considerations

## 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


## Silica Fume

- Wet curing for 7 days regardless of temperature

## 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

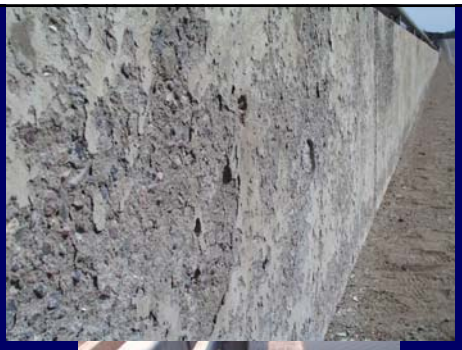

## Advantages to Using SCMs

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

# Limitations

## Severe Highway Environment

## Scaling

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

## Scaling

Related to the following:

- **Concrete over 1.5 hour limit**
- **Re-tempering with water**
- **Poor curing**
- **Slow strength gain (cold weather)**


- **Insufficient maturity when first exposed to deicing salts**
- **Lack of air entrainment in the surface layer or in the bulk**

## MTO Concern with Increased Risk of Scaling

- Fly ash and slag reduce salt scaling resistance, more susceptible to poor construction practices – therefore replacement limits in place
- At the current MTO replacement levels (10% fly ash and 25% slag) scaling in the field about the same as with portland cement concrete

## Overall MTO Experience with SCMs

With the checks and balances that MTO has in place, MTO's experience with slag, fly ash and silica fume to date has been positive.

# Future Development

- Increased replacement levels (30-35%) may be considered but only if tied to longer term warranties to address the SCM's reduced resistance to salt scaling