LEED™ and CONCRETE

Case Studies using Fly Ash

“ The World will not evolve past its current state of crisis by using the same thinking that created the situation.”

~ Albert Einstein

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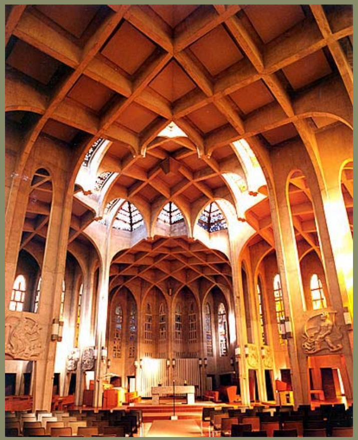
2006

MATERIALS AND SYSTEMS CONCRETE

UBC LIFE SCIENCES CENTRE



WESTMINSTER ABBEY

WHAT'S INHERENTLY GREEN?

- Good durability/longevity
- Mass – can be used as a heat sink
- Locally produced with local raw material
- Little waste – lok block, reuse of formwork, precast
- Versatile in form, to expose and efficient in use of material
- Good fire and acoustic resistance

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HOW CAN CONCRETE BE GREENER

- **Supplementary Cementing Materials (SCM's), to reduce cement in concrete**
  - **fly ash**
  - **blast furnace slag**
  - **silica fume**

- Recycled water
- Good waste management plan
- Recycled aggregate
- Consider recyclability i.e. demountable systems
- Strategies for stormwater management and heat island effect

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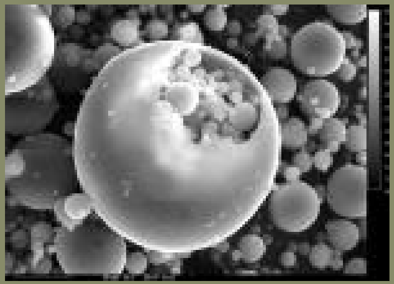
SUPPLEMENTARY CEMENTING MATERIALS FLY ASH

NATURAL POZZOLAN



FLY ASH

1 TONNE OF CEMENT:

- Releases 1 tonne of CO_2
- Consumes 5 million BTU of energy
- Uses 2 tonnes of raw materials

FLY ASH:

- Is a waste product or the coal industry
- Benefits include:
  - Improved concrete properties
  - Environmental
  - Economic
- Challenges include:
  - Lower early strength gain
  - Curing

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Element	Min. Strength (MPa)	Slump (mm)	Max Agg. (mm)	Exposure Class
Slabs, Slab Bands, & Beams	30	70	20	N
Interior Walls	25	80	20	N
Interior Columns	30	80	20	N
Slab-on-grade (Interior Parking)	32	70	20	C-4
Exterior S.O.G, Sidewalks	32	70	20	C-2
Footings	30	80	40	N
Foundation Walls	30	80	20	F-2
Exterior Columns	30	80	20	F-2
Parkade Ramp	35	70	20	C-1
Footings	25	80	40	N
Foundation Walls	25	80	20	N
S.O.G (Interior No Parking)	25	70	20	N

- Specifications
  - Minimum cement targets
  - Curing requirements
  - Trial Mixes
- General Notes Drawings
  - Performance information
  - Curing requirements
- Pre-Construction Meeting
  - Review and clarify requirements
  - Be open for change

SPECIFYING THE USE OF SCM'S

CASE STUDY

TECHNOLOGY ENTERPRISES FACILITY III UBC - 2002

- Six-Storey facility with labs / offices
- LEED™ Silver
- Specific green structural goals
  - Adaptability
  - De-materialization
  - Reduce cement
    - no impact to cost and schedule
  - Early strength tests/solutions

- **Integrated Design Team**

Client:	Discovery Parks Inc.
Architect:	Chernoff Thompson Arch.
Structural Eng:	Read Jones Christoffersen
Materials Eng:	Levelton Engineering
Contractor:	Stuart Olson Const.
Concrete Supply:	Rempel Bros. Concrete

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CASE STUDY - TECHNOLOGY ENTERPRISES FACILITY III
UBC - 2002

Element	Design Strength Mpa (psi)	Volume of Element/ Total Volume	(Cement/Total Cementitious Material)	Cylinder Test Results Mpa (psi)		
				3 Day	7 Day	28 Day
Footings	30 (4350) at 90 days	15%	58%	14.6 (2117)	20.4 (2958)	27 (3915)
Columns and Walls	40 (5800) at 56 days	25%	65%	29.7 (4307)	43 (6235)	51.5 (7468)
Slabs and bands	25 (3625) at 56 days	51%	74%	14.8 (2146)	23 (3335)	30 (4350)
Parking slabs and bands	35 (5075) at 28 days	9%	76%	18 (2610)	34.3 (4974)	40.6 (5887)

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CASE STUDY

TECHNOLOGY ENTERPRISES FACILITY III UBC - 2002

- Options to achieve a higher early strengths with fly ash concrete
  - Lower the water/cement ratio and add plasticizer
  - Add an accelerator
  - Reduce the air content
- Alternate options researched
  - Formwork adaptation
  - Insitu tests

CONCRETE STRENGTH MEASUREMENT

Methods of Testing:

- Lab-cured cylinders
  - Do not reflect site temperatures
  - Use for long term strength measurements
- Traditional field-cured cylinders
  - Sit below hoarding, next to pour
  - Do not benefit from the mass heat
- Lok tests
  - Cast in, measure in-situ strength
  - Measures surface concrete strength
- Cast-in-place punch-out cylinder (CIPPOC) tests
  - Cast in, measure in-situ strength
  - Requires transportation
  - Plastic sleeve blocks some of the mass heat

CASE STUDY:

BISON COURTYARD, BANFF, ALBERTA

FLY ASH USE

- 40% cement replacement
  - Footings
  - Walls
- 35% cement replacement
  - Columns
- 30%, 35%, 40% cement replacement
  - Suspended slabs
- 25% cement replacement
  - Parkade slab-on-grade

Client:	Arctos & Bird Management
Project Manager:	PCL Construction
Concept Architect:	William McDonough + Partners
Primary Architect:	Zeidler Carruthers & Associates
Structural Engineer:	Read Jones Christoffersen Ltd.

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CASE STUDY:

BRIDGES – THE VENTO CALGARY

FLY ASH USE

- 50% cement replacement
  - Footings
  - Columns
- 45% cement replacement
  - Walls
- 40% cement replacement
  - Suspended slabs
  - Slabs-on-grade

Client:	Windmill Developments
Project Manager:	Stuart Olson Contracting Inc.
Architect:	Busby, Perkins + Will
Structural Engineer:	Read Jones Christoffersen Ltd.

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CEMENT REPLACEMENT

% Fly Ash = % Cement Reduction?

- 30MPa Mix – 300 kg cement
    - 40% cement replacement = 120 kg
  - "40% Fly Ash Mix"

144 kg fly ash

216 kg cement

360 kg total CM

Actual cement reduction = 84 kg

(only a 28% reduction)