

CONSEM 2014

materials for modern concrete seminar

Update on cementitious extenders & their application

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- **Types of extenders**
- **Availability of extenders**
- **Methods of use**
- **Extender specifications**
- **Extender Use**
- **Benefits of extenders in concrete**
- **Application examples**

- **Ground granulated blastfurnace slag (ggbs)**
- **Fly ash**
- **Silica fume**
- **Limestone**
- **Other pozzolans**
- **Burnt shale**

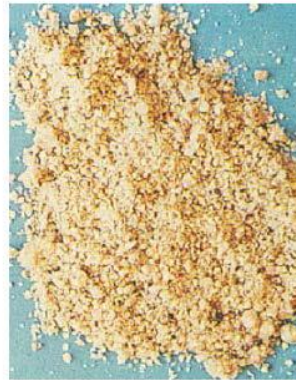
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 - A secondary product of Iron production
 - Slag is rapidly quenched – granulates
 - Granulated slag is milled
 - Chemically similar to cement
 - Reacts with water in a high pH environment - hydraulic

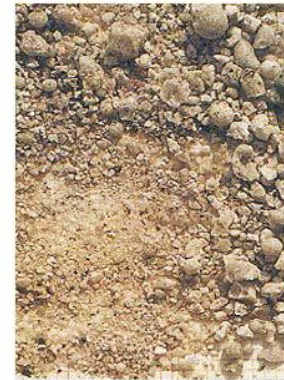
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Air-cooled bfs

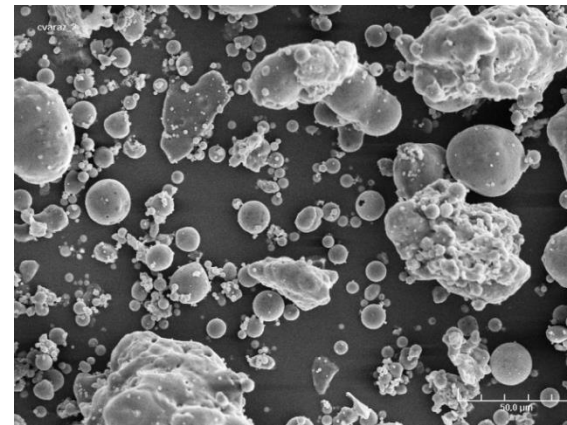
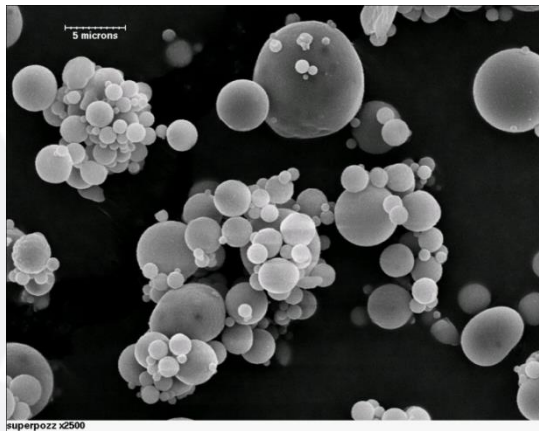


Granulated bfs



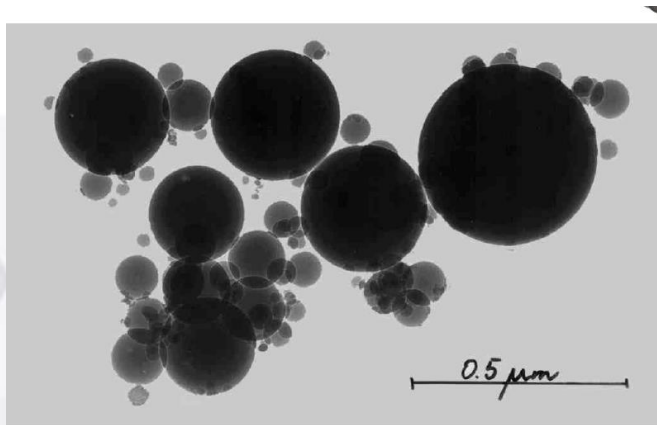
Pelletized bfs

- **Fly ash**
 - Secondary product from thermal power plants
 - Typically from combustion of pulverized coal
 - Separated from the combustion gases by electrostatic precipitators into hoppers
 - Ash plants collect and process
 - Pozzolan – Reacts with CH and not water

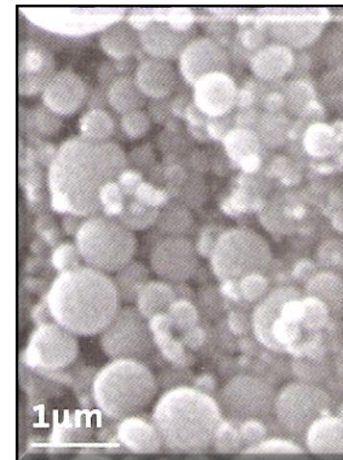


- **Silica fume**

- By-product of silicon and ferro-silicon smelting process
- Gas rises in furnace, cools and forms microsilica spheres $\pm 0.15 \mu\text{m}$
- Collected after cyclone in bag filters
- Undensified 250 kg/m^3 difficult to handle and use
- Densified electrostatically to 700 kg/m^3
- Very reactive pozzolan



Very light and difficult to handle



Types of extenders

- **Limestone**
- **Other pozzolans**
- **Burnt shale**

- **Slags**
 - Vanderbijlpark
 - Newcastle
 - Saldanha (Corex)
 - Middelburg (Chrome)
- **Fly ash**
 - Mpumulanga (Kriel, Matla and Kendal)
 - Limpopo (Matimba)
 - Free State (Lethabo)
 - KZN (Majuba)

- **Silica fume**
 - Mpumulanga (Rand Carbide, Witbank and Silicon Smelters, Middelberg)
- **Limestone**
 - All cement factory locations
- **Pozzolans**
- **Burnt shale**
 - Generally at cement factory

- **Blended or interground into the cement at the factory or blending plant**
- **Added to concrete on site or at a readymix plant**

Addition at the factory allows tweaking of the performance

- **For addition to cement at the factory**
 - Requirements included in SANS 50197
 - Not very comprehensive
 - Performance of the cement is controlled
- **For use separately in concrete**
 - GGBS
 - Fly ash
 - Silica fume

- **GGBS (was SANS 1491-1)**
 - **SANS 55167-1 Definition, specification and conformity criteria**
 - **SANS 55167-2 Conformity evaluation**
 - **Requirements:**
 - **Chemical: MgO, SO₃, LOI, Cl**
 - **Physical: Fineness, Setting time, Activity**
 - **Durability**
 - **Toxicity**

- **Fly ash (was SANS 1491-2)**
 - **SANS 50450-1 Definition, specification and conformity criteria**
 - **SANS 50450-2 Conformity evaluation**
 - **Requirements:**
 - **Chemical: LOI, Cl, SO₃, CaO, SiO₂, Alkalis**
 - **Physical: 45µm, Activity, Soundness, Setting time, Water requirement**
 - **Durability**
 - **Toxicity**

- **Silica fume** (was SANS 1491-3)
 - **SANS 53263-1 Definition, specification and conformity criteria**
 - **SANS 53263-2 Conformity evaluation**
 - **Requirements:**
 - **Chemical: Si, CaO, SO₃, Alkalis, Cl, LOI**
 - **Physical: Specific surface, Activity**
 - **Durability**
 - **Toxicity**

- **Slower setting and lower early strengths**
- **Slight increase in bleeding**
- **Slightly extended striking times**
- **Effective curing essential**

Use of Fly Ash

- **Reduced water requirement**
- **Improved workability**
- **Improved cohesion**
- **Effective curing essential**
- **Slightly increased setting times**

- Increase in water requirement if more than 5% then use superplasticisers
- Improves cohesion and pumpability
- Greatly reduced bleeding – may increase risk of plastic shrinkage cracking

General Benefits

- Use less natural resources (limestone, clay and shale)
- Clinker reduction
- Reduction in CO₂ emissions
- Conserves energy resources: coal to fire kilns
- Conserves energy: no high temperatures
- Use of secondary products from other industries
- Improved durability

- All contributing to increased sustainability

- Improved impermeability
- Improved freeze-thaw resistance
- Good abrasion resistance if well cured
- Improved sulfate resistance
- Reduced potential for AAR
- Lower heat of hydration
- Reduced temperature rise in mass concrete
- Improved resistance to chloride ingress

- Improved impermeability
- Improved resistance to chloride ingress
- Increased chloride binding capacity
- Improved resistance to sulfate attack
- Lower heat of hydration
- Lower peak temperature in mass concrete
- Prevention of AAR

- **Significantly improved compressive and flexural strength**
- **Significantly reduced permeability**
- **Reduced diffusion of chloride ions**
- **Increased electrical resistivity**
- **Significantly improved chemical resistance**

- **Equivalent to sulfate-resisting cement**
- **Good suppression of alkali-silica reactivity**
- **Reduced Shotcrete rebound**
- **Increased abrasion resistance**
- **Enhanced Shotcrete cohesion, compaction and strength**
- **Increase in service life in aggressive, chemical, marine environments**

- **Structural concrete in non-aggressive environment**
 - Any SANS 50197 cements
 - Site blends of SANS 50197 cements and ggbs or fly ash.
 - Be careful of overall extender content especially in cold weather
- **Alkali-reactive aggregate**
 - >50% ggbs or > 30% fly ash

- **Large placements**
 - Use low heat cements or high extender contents
- **Precast**
 - Need high early strength cements to ensure rapid mould turnover
- **Reinforced concrete in marine environment**
 - High ggbs or fly ash contents

- **Understand the different extenders and their benefits**
- **Understand the availability**
- **Specify appropriately**
- **Use standard nomenclature rather than brand names**

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Thank you for listening
Questions?



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