

CSRP'08 conference

18-19 November 2008

Customs House, Brisbane, Queensland

Managing Coal-Fired Power Station Solid By-Products



J T (Terry) Gourley
Geopolymer Alliance

By-products of Power Generation



- Coal-fired power stations generate the following by-products during the energy production cycle:-
 - Flyash
 - Bottom ash
 - Heat

Current uses.



■ ASH

- Typically a small proportion (say 10%) of flyash is used as a supplementary cementitious material (SCM) in the retailing of ordinary Portland cement (OPC) blends.
 - A blended cement = OPC + SCM's + fillers
- The remainder of the ash is used for fill applications (road base for example) or stored in dams and dry stacks.

By-products from wastes



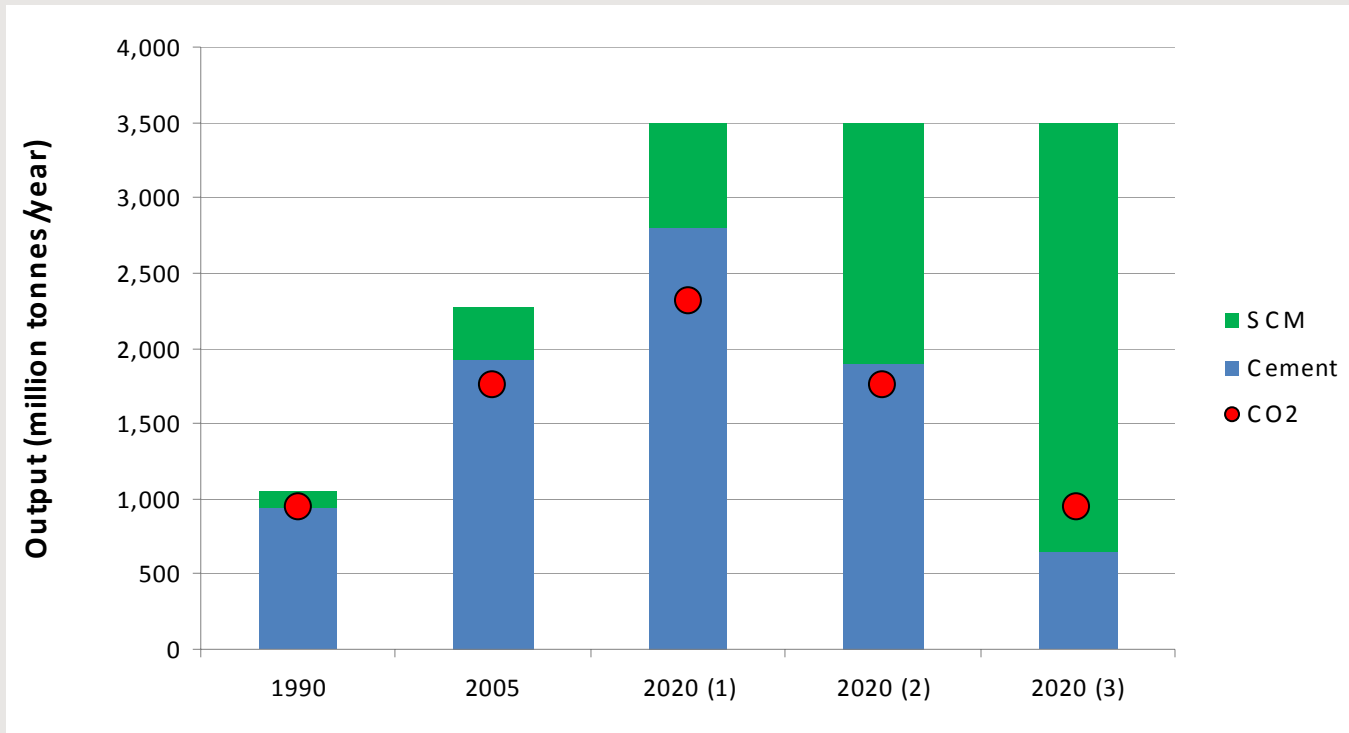
- In theory it is possible to convert all solid wastes to commercially viable by-products for the construction industry, as;-
 - **Aggregates:-**
 - sintered and treated as per Granulated Blast Furnace slag
 - geopolymer pellets
 - **Binders:-**
 - OPC or Geopolymer binder fractions
 - **Zeolites:**
 - Ash + Water + Waste Alkali + Mild Heat

Binder components



- Potential ash-based products include:-
 - Char
 - Coarse flyash
 - Cenospheres
 - Classified flyash
 - Coarsely milled Run-Of-Station (ROS) ash
 - Finely milled ROS ash
 - Very finely milled Classified ash
 - Bottom ash

Predicted World Cement Production



The Need For SCM's



- Just pulling emissions back to 1990 levels (the Aust Govt's target is a 50% reduction on 1990 levels), will require an estimated

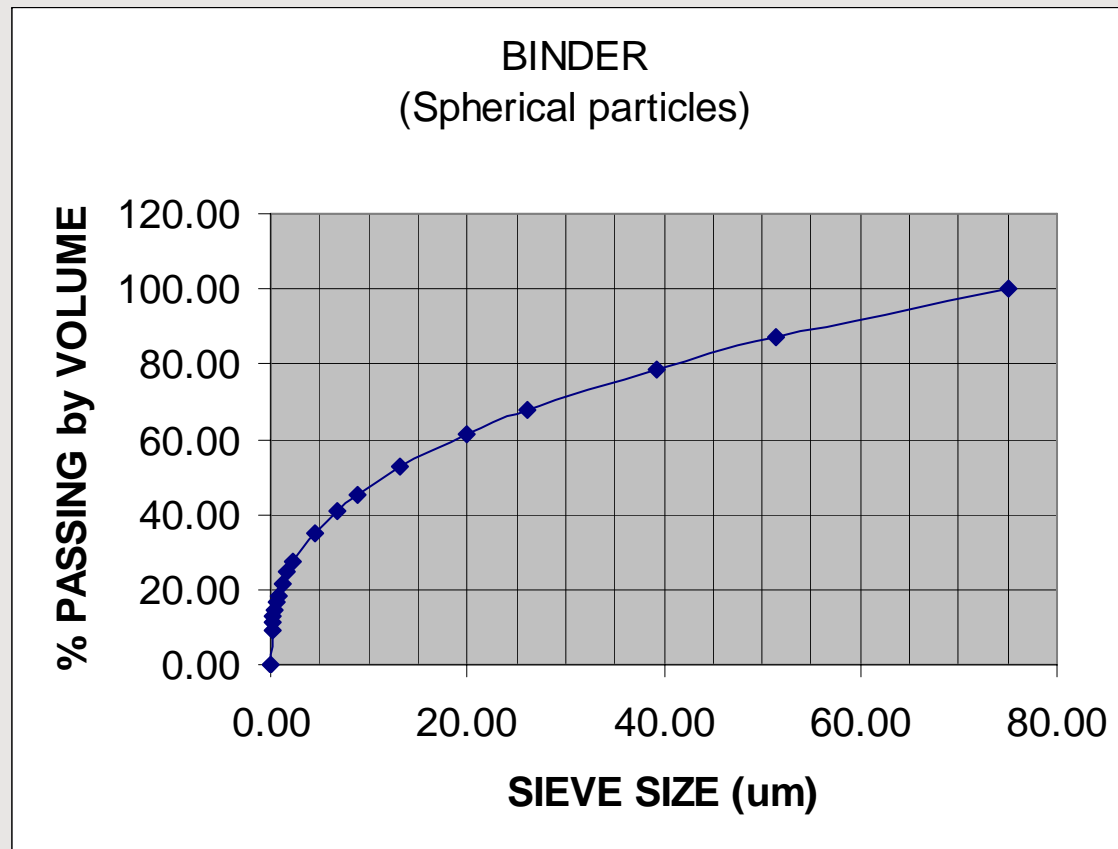
3000 million tonnes of SCM per annum.

The Need for “Engineered” SCM’s

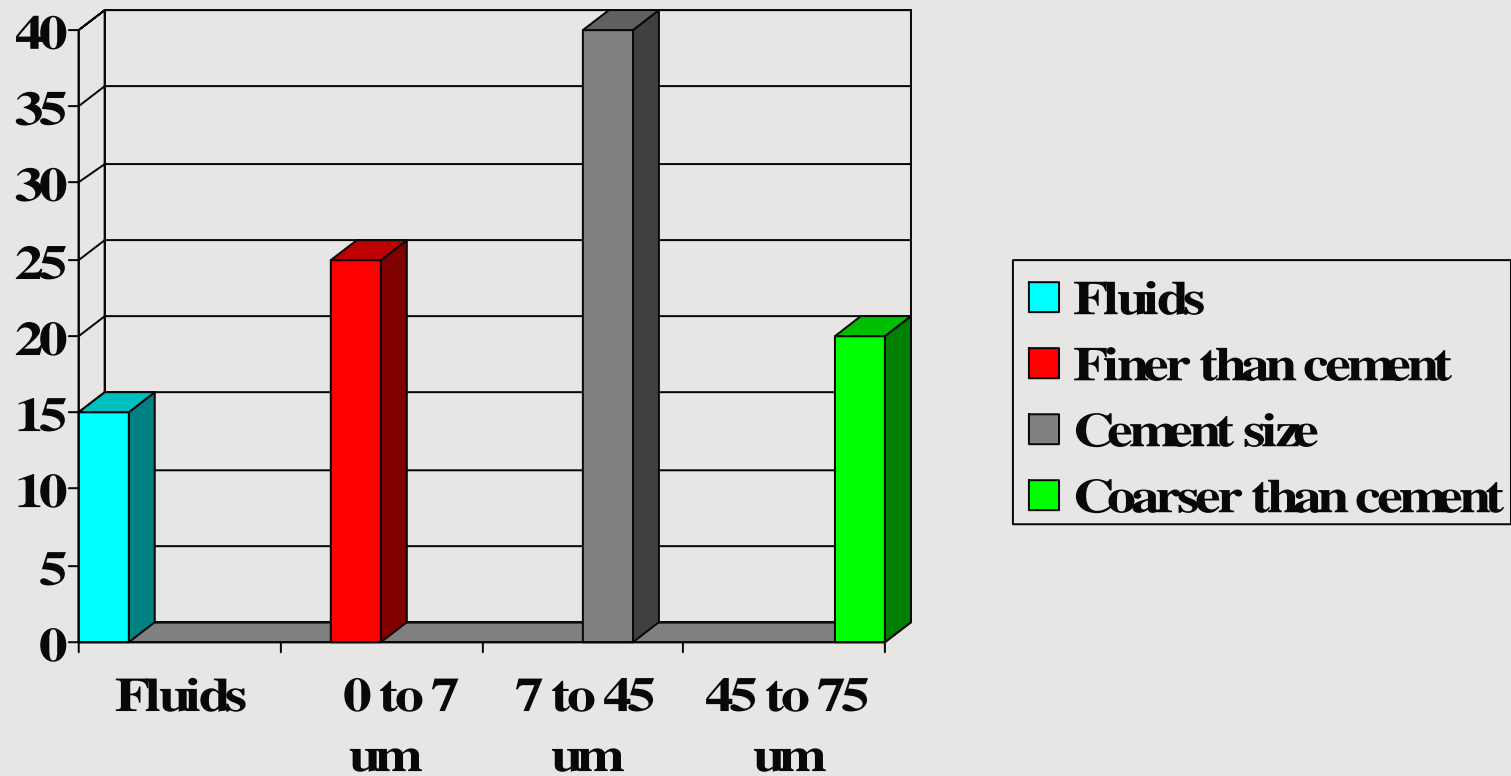


- Currently most SCM’s are processed to make them usable in OPC blends;-
 - Flyashes are classified in cyclones to chose only those particles that match the particle size distribution (PSD) of OPC, with the coarser particles (about 60% of the total ROS ash) being rejected.
 - To achieve the required quantities, this coarser fraction, or ROS itself will have to be milled.
 - Granulated blast furnace slag is ground to form GGBFS.

Optimizing Binder PSD; the optimum packing curve



Binders: Ideal Particle Size Distribution (% by Volume)



Flyash V's Slag



- GGBFS is a more reactive SCM than many flyashes.
- Flyash is much easier to mill;-
 - Flyash milling is like crushing egg shells.
 - Slag milling is chipping small pieces off hard solid particles.
- Milled flyash has a better PSD than milled slag;-
 - Milled flyash has a single mode PSD
 - Milled slag normally has a bi-modal PSD (parent particles + chips)

- Geopolymer binders are composed of only SCM's (no OPC needed)
- Geopolymer concretes can use alkali reactive aggregates. Conventional OPC concretes cannot because of the danger of later age ASR cracking.
 - Hence GPC can use;-
 - Sintered or pelletized flyash aggregate or granulated slag aggregate
 - Bottom ash as a sand.
 - Recycled glass
 - Rounded alkali reactive aggregate (there is now both chemical and physical bonding to the matrix)

Geopolymer Concrete ash usage



* % by mass

Concrete Type	Aggregate:	Aggregate:	Sand:	Sand:	Binder fraction	Binder fraction	Total % SCM
	Normal	Flyash pellets or GBFS	Normal	Bottom ash or GBFS	OPC	SCM	
OPC Concrete	55*		30		12	3	3
GP Concrete		55		30		15	100