

Ash and Gypsum Beneficiation

Rags to Riches

2nd August 2023

Kelley Reynolds-Clausen

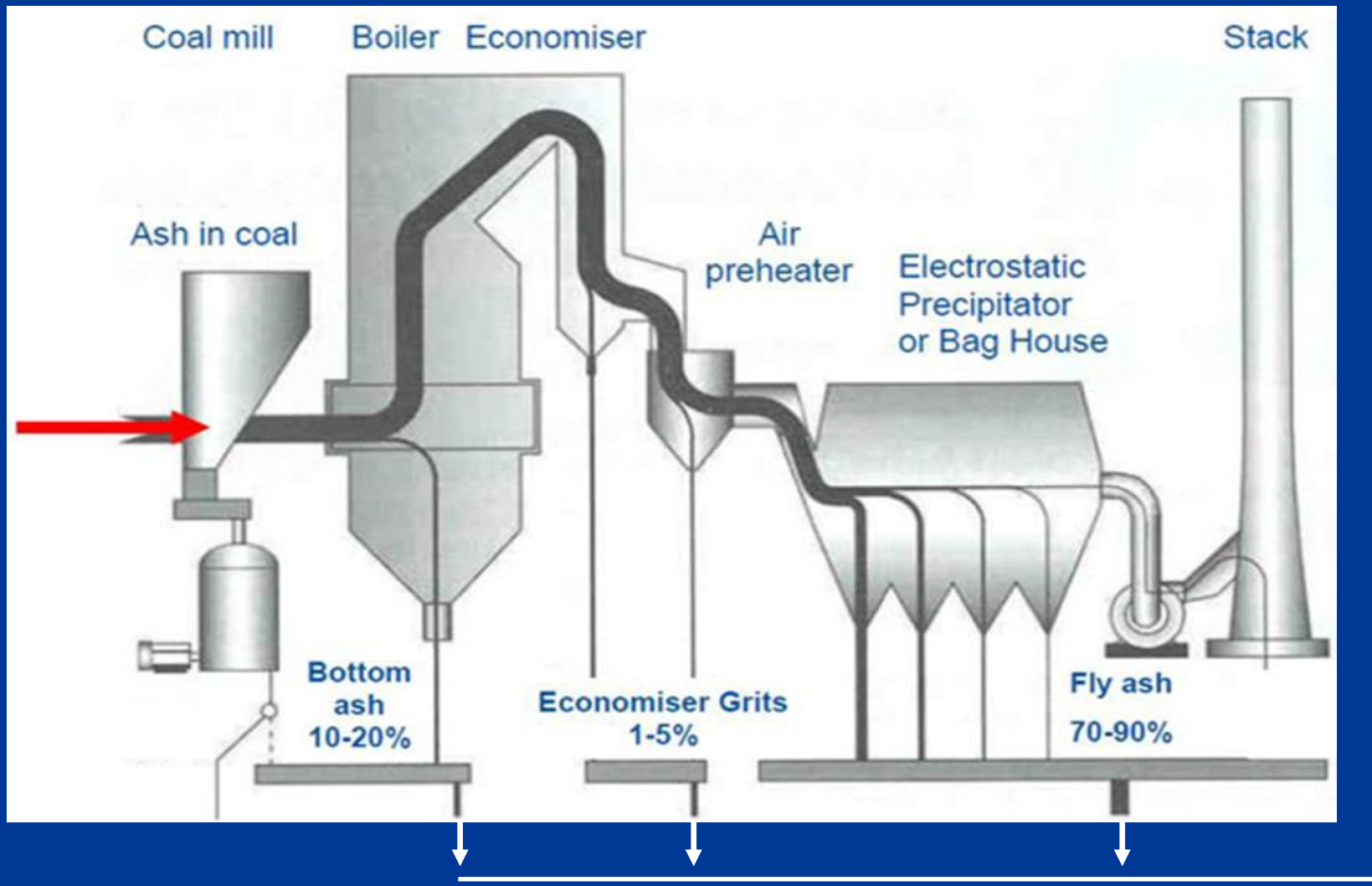
reynolka@eskom.co.za

011 629 5028

082 880 5642



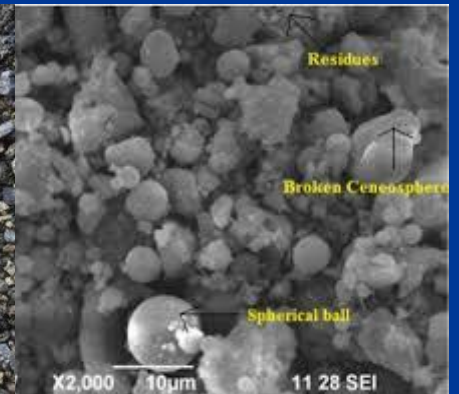
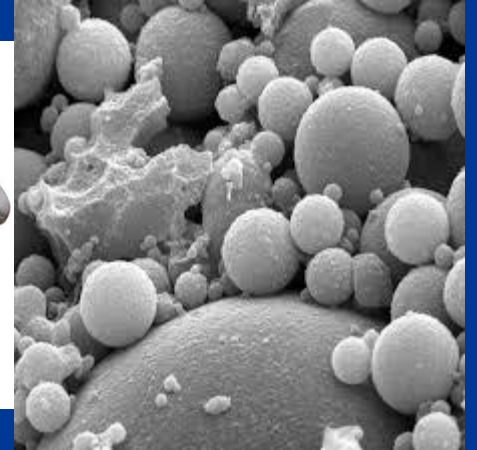
Coal ash generation



INTRODUCTION



- Grey powder formed by inorganic matter after combustion of coal. 34 million tons per annum, 1.9 billion tons stored.
- Fly ash
 - Small, fine particles (0.01-100 μ m diameter)
 - 85-90%
 - Spherical glass aluminosilicate
 - Captured by ESP or bag filters
- Coarse / Bottom ash
 - Heavier particles
 - 10-15%
 - Base of the boiler
 - Collected by submerged scraper conveyor
- Dumped ash
 - Combination of 80:20 Fly ash : Bottom ash
 - Weathered
 - Reactive
 - Vast volumes



INTRODUCTION



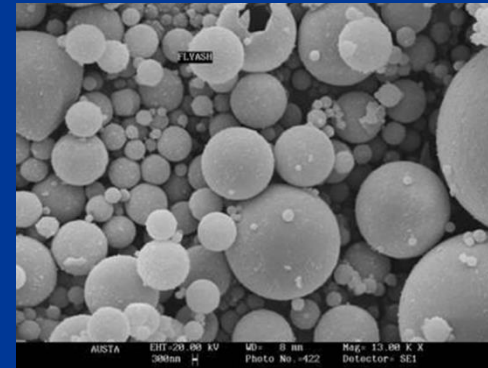
- Obtains physical and mineralogical properties from
 - Parent coal
 - Combustion conditions
 - Temperature
 - Air : fuel
 - Milling
 - Rate of combustion
 - Emission control techniques
 - Climate
- Classified as Class C (W) (calcareous) or **Class F (V) (silaceous)** ashes

Properties	Fly Ash Classes	
Silicon dioxide, aluminium oxide, iron oxide	Class F	Class C
($\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3$), min, wt. %	70,0	50,0
Sulphur trioxide (SO_3), max, wt. %	5,0	5,0
Moisture content, max, wt. %	3,0	3,0
Loss on ignition, max, wt. %	6,0	6,0

INTRODUCTION



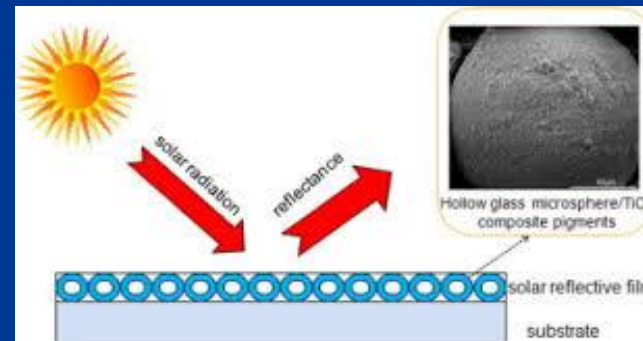
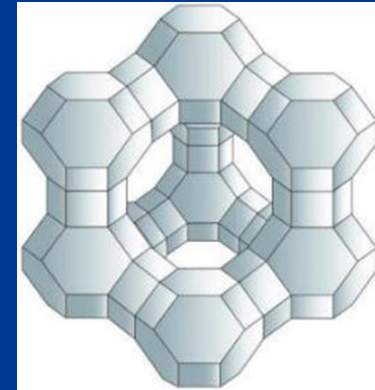
- SA has mostly sub-bituminous coal forming ash which is
 - Highly alkaline (pH 11.5-12)
 - Low iron content
- Eskom ash is unique worldwide
 - Size and pressure of the boilers
 - Combustion techniques
 - Poor quality coal used
 - Ash
 - Highly alkaline
 - Low sulphur
 - Low carbon
 - Pozzolanic
- Beneficiation relies on one or more of the properties
 - Spherical shape
 - pH
 - Pozzolanicity
 - Variety of particle sizes



So, what can we do?

Well to start....

- Ash in Rubber extension
- Ash Mine Backfilling
 - Standards and Guidelines
 - Trials for environmental monitoring
- Zeolite production from Ash
- Ash in paint extension
- Ash to treat eutrophication in water
- Ash information books



Road Construction

Fly ash utilisation in road construction

Basic laboratory studies

Fly ash characterisation

Detailed laboratory studies

Variability testing

Strength behaviour

Chemical and environmental

Trial sections

Monitor response due to HVS trafficking

Long-term performance assessment

Pavement Design

Technical Guideline for the use of Fly Ash in Road Construction



Soil Amelioration – University of Pretoria

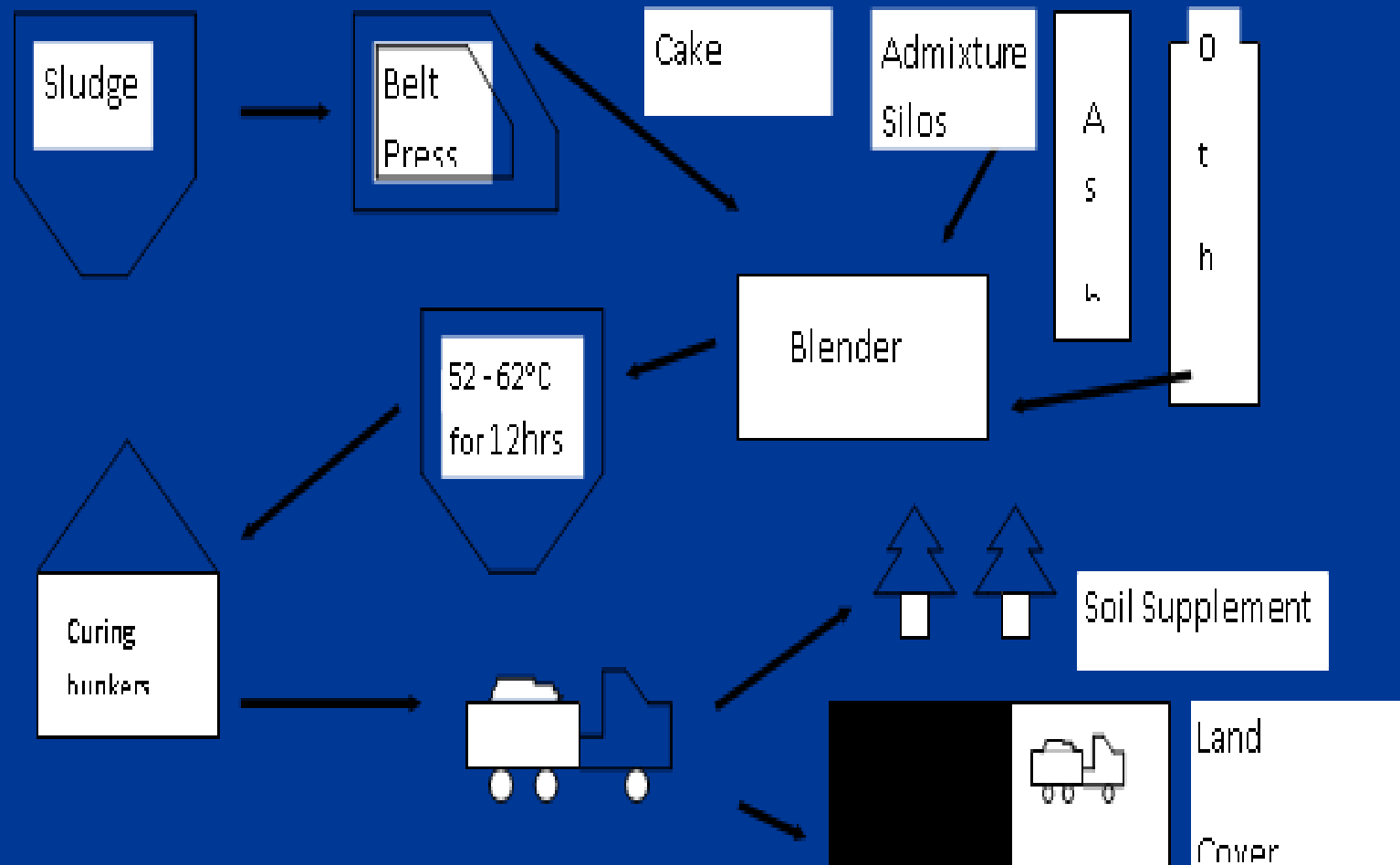


UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Mine land rehabilitation



SLASH – Sewage, Lime ASH

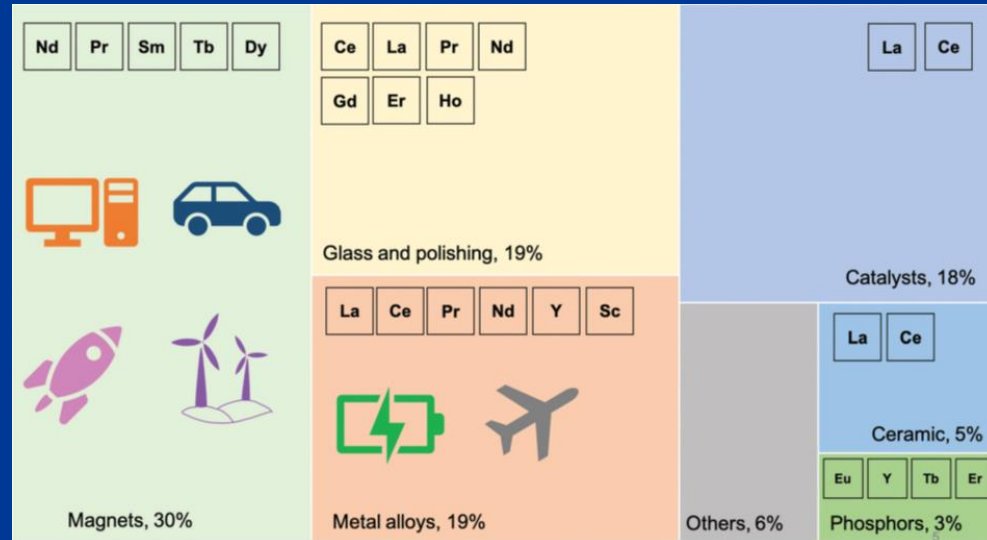


REE Extraction

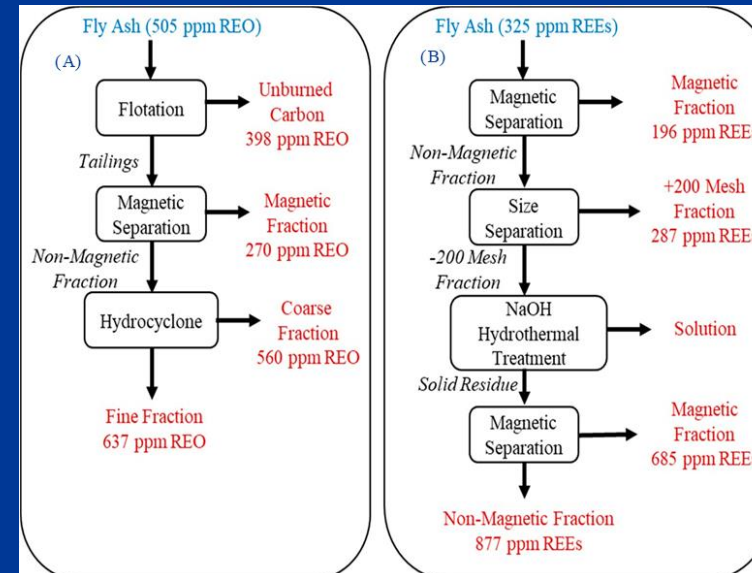
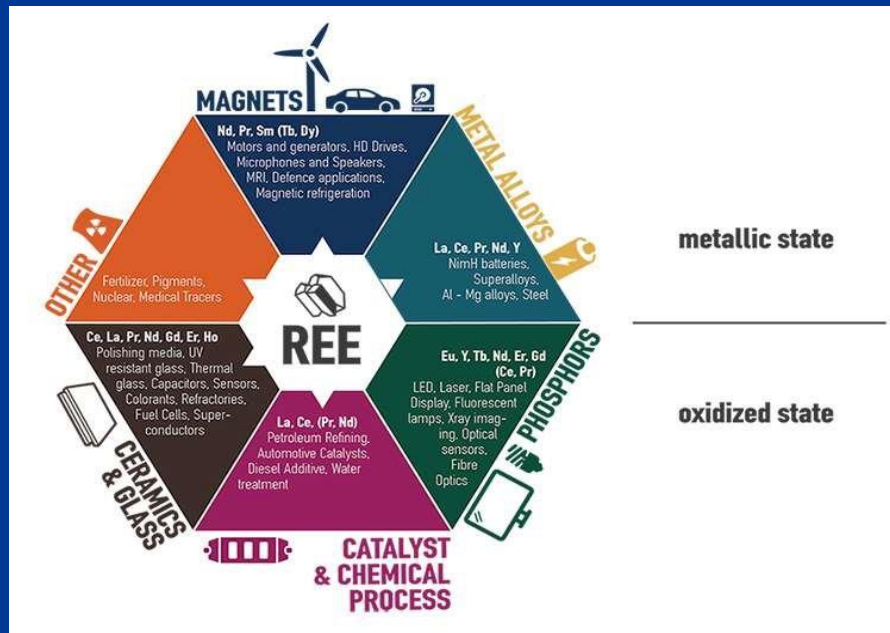
- Rare Earth Elements mostly from China – have limited availability.
- Many research projects on extraction techniques, historically not cost effective.
- Need to understand what is available in Eskom ashes.
- Evaluated all dumped ashes in Eskom fleet.

Rare Earth Elements					
21	Scandium	Sc	64	Gadolinium	Gd
39	Yttrium	Y	65	Terbium	Tb
57	Lanthanum	La	66	Dysprosium	Dy
58	Cerium	Ce	67	Holmium	Ho
59	Praseodymium	Pr	68	Erbium	Er
60	Neodymium	Nd	69	Thulium	Tm
61	Promethium	Pm	70	Ytterbium	Yb
62	Samarium	Sm	71	Lutetium	Lu
63	Europium	Eu			

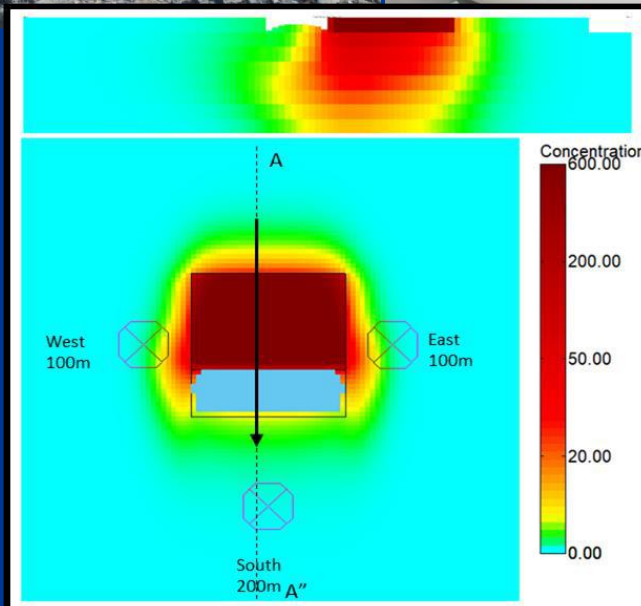
REE Extraction



**Possible value of
ONLY Kendal ash
dump is R2.38
Trillion.**



Mine Backfilling



Mine Backfilling



[illegible]

Why Alkali Activated Coal Ash concrete?



- Fly ash and slag inexpensive raw material (wastes)
- Environmentally friendly –
 - Considered user friendly – new activators
 - Historical activators – hazardous, toxic and corrosive
 - Cures at room temperature .
 - Dissolution of the silica and aluminium controls the alkali activation process.
- Site specific
- Silica content from 40 – 60%, aluminium between 20 and 30%
- High aluminium content with low calcium
- Sulphur compounds, unburnt coal (carbon) and some iron compounds
- Better heat resistance - no hydrates in structure.
- Resistant to corrosion from seawater - attributed to the lack of calcium in their structure.
- Shows little or no alkali-aggregate reaction (AAR) or alkali silica reaction (ASR) (expansion).



Geopolymer Poles (wood replacement)



- 9 and 11m wooden pole replacement.
- Fire, moisture (rain and rot) and pest (termites, borer beetles) resistance.
- Must meet specifications for wood poles.

Geopolymer Poles

- 9 and 11m wooden pole replacement.
- Fire, moisture and pest resistance.
- Must meet specifications for wood poles.
- Will be spun pipes – wire encasement.
- No metal reinforcing – plastic fibre.



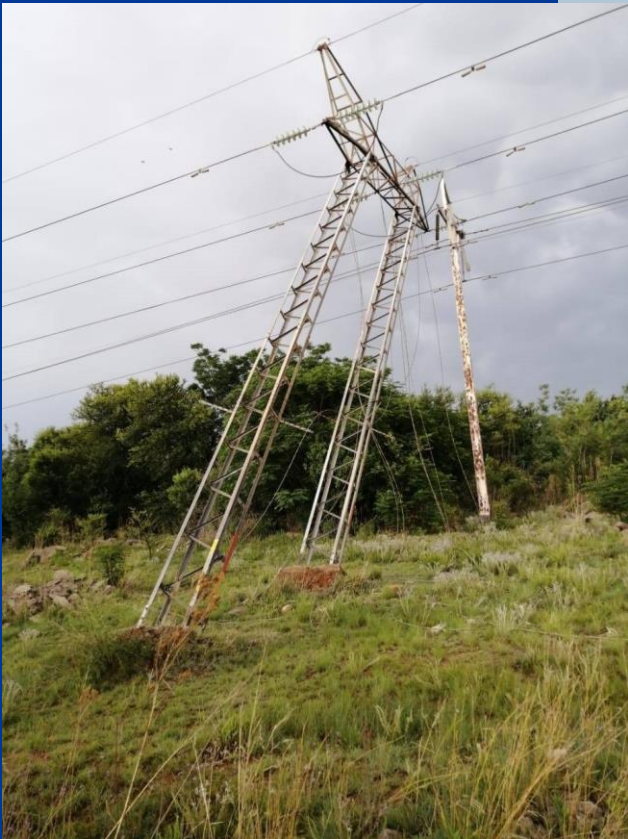
Coal ash-based Shotcrete



- Fly ash based Shotcrete
 - Spray on – minimal bounce off
 - Sets within 3s – 1.5 mPa
 - 70mPa after 28 days and 150 mPa after 6 months – will need two types of diamond blades to cut.



Alkali Activated Shotcrete applications for Pylons



Shotcrete and Alkali activated applications for Tx and Dx



- Shotcrete to be applied to pylon metal components as a coating – will passivate metal and minimise theft as it cannot be cut.
- Shotcrete Gabions to maintain structure and avoid theft of the cage and stones.
- Possible to shotcrete distribution boxes to avoid vandalism.
- A low strength Alkali activated formulation can be used to fill sink holes and erosion trenches.
- No possible leaching so a safe environmental option.



Cahora Bassa Transmission line



Proposed stabilisation costs with ash reduce the costs from R750 000/pylon to approx. R50 000 = 97% reduction in cost!

Poor Quality Soil Improvement – foundations - Tx



- Improvement of active clay, compressive or compacting soils
- Addition of coal ash, slag and activator to soil → improves soil grading.
- Strength – 0.75MPa
- Beneath substations for construction support.
 - 300m x 300m x 1.5 – 3m of earth work removal.

Can reduce the cost of substation base construction from approximately R63 M to approximately R22 M per 300x300m sub station.



Not considering savings on testing, machinery and manpower on the lesser volume.

CO₂ reuse

- Use of CO₂ and flue gas for enhanced curing and strength development in zero cement concrete.
- Carbon aids setting.
- Crystal formation enhanced.
- Initial investigations and laboratory testing





Thank You



Kelley Reynolds-Clausen

reynolka@eskom.co.za

011 629 5028

082 880 5642