Optimising the Strength of Concrete Without using Cement Professor Pete Claisse, Seema Karami Coventry University UK

### Materials

- Strength Tests
- Other tests
- Site Demonstrations



### **Materials**



ROSA = Run o PG = Plasterbo RG = Red Gyp

ROSA = Run of Station Ash (Coal fired power plant) BPD = By-pass dust (Cement works)
 PG = Plasterboard (wall board) gypsum BOS = Basic Oxygen Slag (Steel works)
 RG = Red Gypsum (Titanium dioxide pigment plant)

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### Laboratory Testing



1- Mix, 5 min



#### **2- Samples**

3- Crush Samples,3, 7, and 28 days





### **Trial Mixes**



#### = 50 MIXES (300 samples) 0.3 liquid/solids in every mix



#### **BOS + ROSA + BPD Compressive strength MPa**



BOS%

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#### BOS + ROSA + RG

#### **Compressive strength MPa**



RG = Red Gypsum (Titanium dioxide pigment plant)

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#### **Mathematical Modelling Comparisons**

BOS	0.32	0.51	0	0.64	0	0.8	0	0.12	0	0.5	0.35	0
BPD	0.6	0.34	0.05	0.2	0.1	0.08	0.15	0.48	0.18	0	0	0.1
ROSA	0.08	0	0.855	0.16	0.81	0	0.765	0.4	0.72	0.45	0.45	0.81
PG	0	0.15	0	0	0	0.12	0	0	0	0	0	0.09
RG	0	0	0.095	0	0.09	0	0.085	0	0.1	0.05	0.2	0
Comp. Strength Mpa.	4.47	5.01	7.00	7.19	7.99	9.60	10.01	12.36	12.99	13.79	15.40	15.81





## The Optimised Mixture Designs

BOS%	ROSA%	RG%	PG%	W/C	7 Day Strength MPa	28 Day Strength MPa	Density Kg/m <sup>3</sup>
10	40	10		0.2	2.6	17 5	2024
40	40	12		0.2	2.0	17.5	2024
40	50	10		0.23	2.7	18.2	1912
40	50		10	0.2	2.0	19.4	1904
30	60	10		0.73	2.5	18.9	1820
30	60		10	0.47	2.38	18.6	1823



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#### **Sample Expansion**





#### BOS+BPD+PG+30%L/S



#### BOS+ROSA+RG+27%L/S



#### BOS+ROSA+RG+25%L/S



Other tests carried out or in progress Rheology – viscosity and yield point Freeze-thaw Permeability (picture below) Diffusion (picture below)



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### The mixture designs for the trials

Trial	Pour	Cementitious component	Strength MPa
1	Cell 1 top	Spent borax 100%	4.5
2	Cell 2 top	CKD 60%, Lagoon ash 40%	1.7
3	Cell 3 top	CKD 60%, Lagoon ash 40%	1.3
1	Cell 1 base	GGBS 90%,OPC 10%, Sodium sulphate	13
2	Cell 2 base	CKD 60%, PFA 40%, Sodium sulphate	6.9
3	Cell 3 base	OPC 5%, CKD, 70%, Lagoon ash 25%	6
4	Trench fill	BOS 60%, Red Gypsum 40%	1.8
5	Sub-base	BOS 80%, PB 15%, BPD 5%	10.8
6	Base course	BOS 80%, PB 15%, BPD 5%	30.55





# Secondary materials in the mixes



SOUTHERN CALE FRINA CHAPTER



# Placing Trial 4.





### The "Coventry Blend"

- Basic oxygen slag from steel manufacture (80%)
- Waste plasterboard (15%)
- Kiln by-pass dust from cement manufacture.(5%)
  100 Tonnes of this blend were made for trials 5 and 6

This blend is not recommended for partial replacement of cement – it is for use without cement





# Trial 5 Car Park



### Trial 6 Haul Road – Soil Stabilisation











# Trial 6 Semi-Dry Paste/grout



American Concrete Institute

## Concrete without Cement (Trials 5 and 6)



Concrete (trial 5)





Semi-dry paste/grout

(trial 6)

## **CONCLUSIONS 1**

- Viable mixtures which contain little or no Portland cement can be made for a wide variety of applications.
- Site trials represent the best route to develop these mixtures for commercial use.
- Pre-blended mixtures are the best way to use powder which contains several mineral wastes.



## Conclusions 2

- While it is possible to demonstrate the viability of cementitious mixtures which are sustainable there are many difficulties which may prevent their industrial use. These include:
  - Insurance problems
  - Lack of capital investment
  - Environmental concerns which may or may not have any scientific basis



### Thank you

# For more information please visit www.claisse.info

