Biomass Fly Ash in Concrete II

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Objective:

This poster determines the strength build-up and quantitative kinetics of pozzolanic reaction between biomass /coal ash with $Ca(OH)_2$. The strength of biomass ash samples is **2-3 times** stronger than coal ash ones and even comparable to those of pure cement ones (2-in cube); The $Ca(OH)_2$ consumption rate was determined by TGA and the data imply a diffusion controlled mechanism.

Reaction Mechanisms

Cement Hydration

$$2Ca_3SiO_5 + 7H_2O \rightarrow 3CaO{\bullet}2SiO_2{\bullet}4H_2O + 3Ca(OH)_2$$

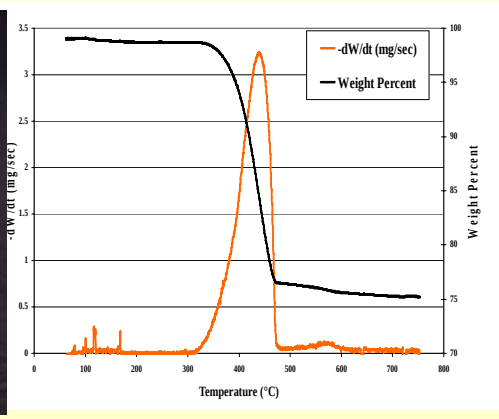
Pozzolanic Reaction (fly ash with $Ca(OH)_2$)

$$3Ca(OH)_2 + 2SiO_2 + H_2O \rightarrow 3CaO{\bullet}2SiO_2{\bullet}4H_2O$$

Vacuum sealed in Mason Jar

Keep samples from CO_2 attack.

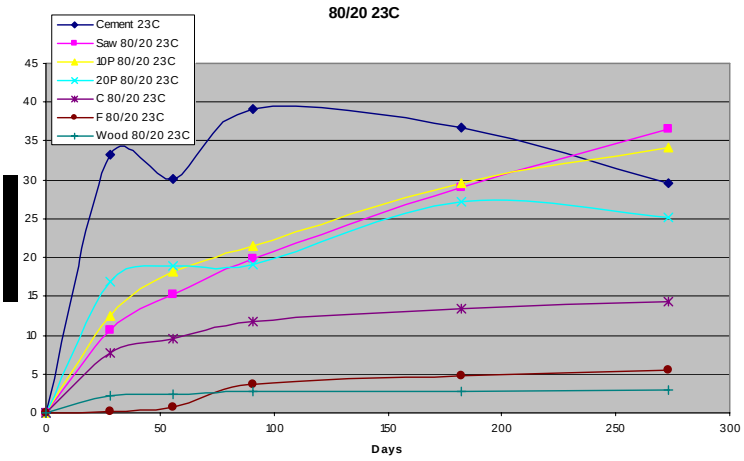
TGA Analysis of $Ca(OH)_2$



Experimental Setup

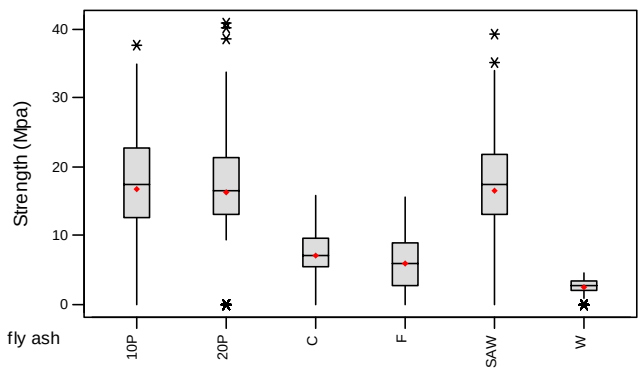
Item		Description
Fly ash	(6)	C, F, Wood, SAW, 10P and 20P
Water/ /(fly ash + $Ca(OH)_2$)	(mass)	0.5
Sand /(fly ash + $Ca(OH)_2$)	(mass)	2
Fly ash / $Ca(OH)_2$	(mass)	80 / 20, 70 / 30, 60 / 40
Temperatures	(3)	23ºC, 43ºC, 63ºC
Testing Dates	(6)	1, 2, 3, 6, 9 and 12 months after mixing
Replicates		2

Strength Build-up



Statistical Analysis of Strength Build up by Fly Ash

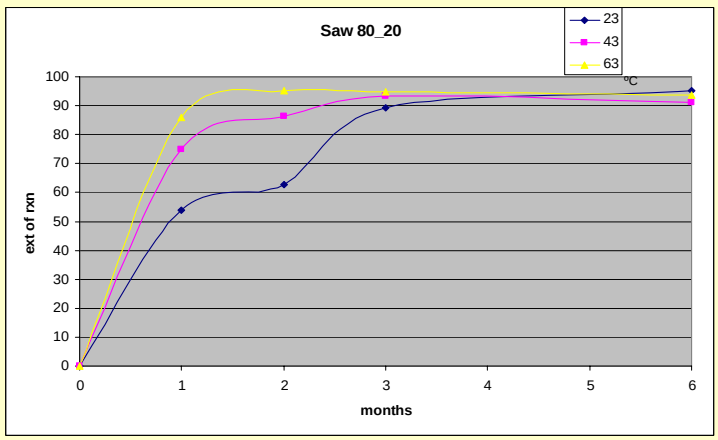
(means are indicated by solid circles)



Bottoms and tops of boxes represent the 95% confident intervals

Quantitative Kinetics

(first order to fly ash and $Ca(OH)_2$, respectively)



$$\frac{d\alpha_{Ca(OH)_2}}{dt} = k(1-\alpha_{Ca(OH)_2})(1-\alpha_{ash})$$

	K^0 (month^{-1})	Ea/R (K)	b	R^2
Class F	199453	3639	1.857	0.95
Class C	38.71	986.2	2.28	0.94
Wood	5.05	191.1	2.99	0.93
10P	2408	2316	1.74	0.94
20P	2535	2391	1.86	0.93
SAW	245700	3688	1.71	0.96

b is the stoichiometric parameter, one gram of fly ash combines with b grams of $Ca(OH)_2$