Review of Agro-Waste Ashes used as Cement Replacement for Concrete Structures in the South-West of the United States

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Abstract: In this review study, the use of selected agricultural biomass residues ash as a cement replacement in the South-West region of the United States was investigated. In this region 68% of rice, 43% of the cotton, 82 % of the sorghum, 31 % of wheat, 9% of soybean, and 8.2% of corn commercially produced in the U.S. The use of the generated biomass residues as a replacement for coal and fossil fuel appears to be a safe mean to improve the global warming impact and total environmental footprint of the cement industry.

1. Introduction

Global energy and process related carbon dioxide (CO_2) emissions from manufacturing cement are estimated to be around 5% of the global CO_2 emissions (Murray et Al., 2008) . Little has been done in the United States to use the biomass locally grown crops as cement replacement secondary fuel replacement for coal and fossil source of energy for cement manufacturing. The resulting ash is then milled and used as part of the components of cement. The quantity of the agricultural biomass residues that are necessary to replace one ton of coal depends on the residue's energy value and water content. The average value ranges between 1.6 and 2 tons of biomass residues per ton of coal replaced.

2. Objectives

The objective of the study was to investigate the potential of using agricultural biomass residue ash as a replacement for cement in concrete.

3. Literature review

The rate of replacement can go up to 50% concerning the rice husk ash without reducing the properties of the conventional cement. The ash contents in various agro-wastes are summarized in Table 3.1. Literature review indicate that upto 50% of cement replacement with agro-waste ash. Composition of various ashes are summarized in Table 3.2. The agro-waste was rich in SiO2 but were low in CaO (Table 2)

Table 3.1: Chemical composition and ash content *

Material	Ash content	C content (% by dry wt,)	C EF (tons C-eq/ton)	ΔCO_2 (ton/ton coal replacement)	Associated emissions	Data source*
Rice husk	20.6	38.8	0.35	0.0	Cl	1,2,3
Rice straw	18.67	-	-	0.0		2
Wheat straw	3.5-9	44.9,48.8	0.42	0.2		1,2,3,4,5
Corn Stover	3-7.5	42.5	0.28	-0.6		3,4,6
Sugar cane leaves	7.7	39.8	0.34	-0.1		
Sugar cane (bagasse)	4.2	44.1	0.39	0.4		7,3,4
Sorghum						
Soybean						

Cotton stalk	3.3					
Saw dust	2.6	46.9	0.38	0.14	Cl	8,3
Waste wood	0.9	50	0.33,0.49	1.32	Cl	9,7,10,5

* 1-Mansary (1997), 2- Jenkins, Baxter et al. (1998), 3-Demibras (2003), 4-Asian Development Bank (2006), 5-Mc Ilveen Wright (2007), 6- Mani, Tabil et al. (2004), 7-Li (2004), 8- Resource Management Branch (1996), 9-Bhattacharya, Abdul Salam et al. (2000), 10-IPCC (2006)

Table 3.2: Chemical composition of the cement clinker/RHA, RSA & WSA (Murray et al., 2008)

	Clinker (%)	RHA	Rice straw	Wheat straw
CaO	63-67	2.04	2.4-3.01	6.14
Al_2O_3	4-7	1.04	-	-
MgO	0.6	0.8	3.11	1.06
Fe_2O_3	2-4	0.3	0.2	-
SiO_2	21-24	78.4	74.67	55.32
Trace amounts	2-3	-	-	1.06
K_2O	-	3.71	12.3	25.6

4. Conclusion

Based on literature review, the following conclusions can be drawn; Rice straw ash, rice husk ash, and wheat straw ash are pozzolanic materials and satisfies the requirements of ASTM class N, F and C, therefore they can be used as a cement replacement material.

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