

The Use of Fly Ash and Lime Sludge as Partial Replacement of Cement in Mortar

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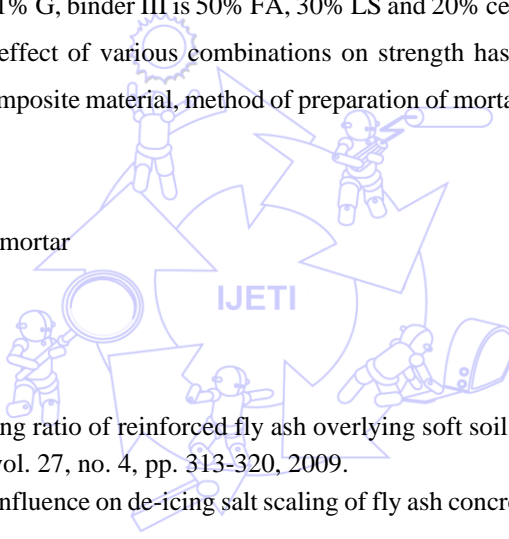
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Abstract

The increased demand of drinking water and power has led huge generation of water treatment plant residue i.e. sludge and the thermal power plant by-product such as fly ash. Large quantities of sludge and fly ash are produced in India and disposed off by landfilling or dumping in and around sites. In this study fly ash and water softening sludge (lime sludge) has been utilized in mortar. Two types of mortar (type I and II) with four binder combinations have been tried. Binder I consists of 70% fly ash (FA) and 30% lime sludge (LS), 0% gypsum (G), binder II is 70% FA, 30% LS and 1% G, binder III is 50% FA, 30% LS and 20% cement and the binder IV is 40% FA, 40% LS with 20% cement. The effect of various combinations on strength has been discussed here. This paper outlines the composition of the composite material, method of preparation of mortar specimen, testing procedure and salient results thereof.

Keywords: Fly ash, lime sludge, mortar

Reference

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- [1] G. Ambarish and D. Utpal, "Bearing ratio of reinforced fly ash overlying soft soil and defomation modulus of fly ash," *Geotextiles and Geomembranes*, vol. 27, no. 4, pp. 313-320, 2009.
- [2] N. M. Aneta, "Water-binder ratio influence on de-icing salt scaling of fly ash concrete," *Procedia Engineering*, vol. 57, pp. 823-829, 2013.
- [3] S. Angelo, O. Robert, G. Terry, and P. Jan, "Artificial lightweight aggregates as utilization for future ashes – A case study," *Waste Management*, vol. 32, no. 1, pp. 144-152, 2012
- [4] A. Das, C. Jayashree, and B.V.S. Viswanadham, "Effect of randomly distributed geofibers on the piping behaviour of embankments constructed with fly ash as a fill material," *Geotextiles and Geomembranes*, vol. 27, no. 5, pp. 341-349, 2007.
- [5] A. Senol, T. B. Edil, B. S. Md.Sazzad, H. A. Acosta, and C. H. Benson, "Soft subgrades stabilization by using various fly ashes," *Resources, Conservation and Recycling*, vol. 46, no. 4, pp. 365-376, 2006.
- [6] S. B. Shafique, T. B. Edil, C. H. Benson, and A. Senol, "Incorporating a fly ash stabilized layer into pavement design," *Proceedings of the ICE - Geotechnical Engineering*, vol. 157, no. 4, pp. 239-249, 2004.
- [7] E. Bou, M. F. Quereda, D. Lever, A. R. Boccaccini, and C. R. Cheeseman, "Production of pulverised fuel ash tiles using conventional ceramic production processes," *Advances in Applied Ceramics*, vol. 108, no. 1, pp. 44-49, 2009.
- [8] K. C. Cameron, H. J. Di, and R. G. McLaren, "Is soil an appropriate dumping ground for our wastes?" *Australian Journal of Soil Research*, vol. 35, no. 5, pp. 995-1035, 1997.
- [9] CPCB, "Assessment of utilization of industrial solid wastes in cement manufacturing," Central Pollution Control Board, New Delhi, 2007.

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- [10] CPCB, "Fly ash generation at coal/lignite based thermal power stations and its utilization in the country for 1st half of the year 2011-2012," Central Electricity Authority, 2011.
- [11] D. Ravikumar, S. Peethamparan, and N. Neithalath, "Structure and strength of NaOH activated concretes containing fly ash or GGBFS as the sole binder," *Cement and Concrete Composites*, vol. 32, no. 6, pp. 399-410, 2010.
- [12] A. Ghosh and C. Subbarao, "Tensile strength bearing ratio and slake durability of class F fly ash stabilized with lime and gypsum," *Journal of Materials in Civil Engineering*, vol. 18, no. 1, pp. 18-27, 2006.
- [13] V. Hequet, P. Ricou, I. Lecuyer, and P. L. Cloirec, "Removal of Cu⁺² and Zn⁺² in aqueous solution by sorption onto mixed fly ash," *Fuel*, vol. 80, no. 6, pp. 851-856, 2001.
- [14] H. Y. Jo, S. H. Min, T. Y. Lee, H.S. Ahn, S. H. Lee, and J. K. Hong, "Environmental feasibility of using coal ash as a fill material to raise the ground level," *Journal of Hazardous Materials*, vol. 154, no. 1-3, pp. 933-945, 15 June 2008.
- [15] S. Horiuchi, M. Kawaguchi, and K. Yasuhara "Effective use of fly ash slurry as fill material," *Journal of Hazardous Materials*, vol. 76, pp. 301-337, 2000.
- [16] I. J. Alinnor, "Adsorption of heavy metals from aqueous solutions by fly ash," *Fuel*, vol. 86, no. 5-6, pp. 853-857, 2007
- [17] I. Kourti and C. R. Cheeseman, "Properties and microstructure of light weight aggregate produced from lignite coal fly ash and recycled glass," *Resources, Conservation and Recycling*, vol. 54, no. 11, pp. 769-775, 2010.
- [18] IS: 4031 (part 4) – 1988, Bureau of Indian Standards, New Delhi.
- [19] C. Jaturapitakkul, K. Kiattikomol, V. Sata, and T. Leekeeratikul, "Use of ground coarse fly ash as a replacement of silica fume in producing high strength concrete," *Cement and Concrete Composites*, vol. 34, pp. 549-555, 2004.
- [20] J. Cuenca, J. Rodriguez, M. Martin-Morales, Z. Sánchez-Roldán, and M. Zamorano, "Effects of olive residue biomass fly ash as filler in self-compacting concrete," *Construction and Building Materials*, vol. 40, pp. 702-709, 2013.
- [21] J. T. Shahu, S. Patel, and A. Senapati, "Engineering properties of copper slag-fly ash-dolime mix and its utilization in base course of flexible pavements," *Journal of Materials in Civil Engineering*, 2012.
- [22] J. W. van de Lindt, J.A.H. Carraro, P. R. Heyliger, and C. Choi, "Application and feasibility of coal fly ash and scrap tire fiber as wood wall insulation supplements in residential buildings," *Resources, Conservation and Recycling*, vol. 52, no. 10, pp. 1235-1240, 2008.
- [23] B. Leelavathamma, K. M. Mini, and N. S. Pandian, "California bearing ratio behavior of soil-stabilized class F fly ash systems," *Journal of Testing and Evaluation*, vol. 33, no. 6, pp. 406-410, 2005.
- [24] R. Mathur, S. Chand, and T. Tezuka, "Optimal use of coal for the power generation in India," *Energy Policy*, vol. 31, pp. 319-331, 2003.
- [25] Ministry of Environment and Forests, Ministry of Environment and Forests (MOEF) notification, Fly ash notification 2007, New Delhi, 3rd Apr. 2007.
- [26] S. Mustafa, O. Y. Ismail, and T. Mustafa, "Transport and mechanical properties of self-consolidating concrete with high volume fly ash," *Cement and Concrete Composites*, vol. 31, pp. 99-106, 2009.
- [27] M. Nattapong, J. Chai, N. Charin, and S. Vanchai, "Effects of binder and CaCl₂ contents on the strength of calcium carbide residue-fly ash concrete," *Cement and Concrete Composites*, vol. 33, no. 3, pp. 436-443, 2011.
- [28] NCC&BM, "Report on Utilization of lime sludge for value added products and productivity enhancement of lime kilns," National Council for Cement and Building Material, New Delhi, 2003.
- [29] N. U. Kockal and T. Ozturan, "Effects of lightweight fly ash aggregates properties on the behaviour of lightweight concretes," *Journal of Hazardous Materials*, vol. 179, no. 1-3, pp. 954-965, 2010.
- [30] N. U. Kockal and T. Ozturan, "Characteristics of lightweight fly ash aggregates produced with different binders and heat treatments," *Cement and Concrete Composites*, vol. 33, no. 1, pp. 61-67, 2011.
- [31] N. S. Pandian, "Fly ash characterization with reference to geotechnical applications," *Journal of Indian Institute of Science*, vol. 84, pp. 189-216, 2004.
- [32] R. A. Aguilar, O. B. Diaz, and J.I.E. Garcia, "Lightweight concretes of activated metakaolin- fly ash binders, with blast furnace slag aggregates," *Construction and Building Materials*, vol. 24, no. 7, pp. 1166-1175, 2010.
- [33] B. S. Sazzad, K. Rahman, M. Yaykiran, and I. Azfar, "The long-term performance of two fly ash stabilized fine-grained soil subbases," *Resources, Conservation and Recycling*, vol. 54, no. 10, pp. 666-672, 2010.
- [34] R. Siddique, "Effect of fine aggregate replacement with class F fly ash on the mechanical properties of concrete," *Cement and Concrete Research*, vol. 33, pp. 539-547, 2003.
- [35] S. Ramesh, "Appraisal of vernacular building materials and alternative technologies for roofing and terracing options of embodied energy in buildings," *Energy Procedia*, vol. 14, pp. 1843-1848, 2012.

- [36] S. Tsimas, and A. M. Tsima, "High-calcium fly ash as a fourth constituent in concrete: Problems, solutions and perspectives," *Cement & Concrete Composites*, vol. 27, no. 2, pp. 231-237, 2005.
- [37] L. W. Titshall and J. C. Hughes, "Characterization of some South African water treatment residues and implications for land application". *Water SA*, vol. 31, no. 3, pp. 299-307, 2005.
- [38] T. Yen, T. H. Hsu, Y. W. Liu, and S. H. Chen, "Influence of class F fly ash on the abrasion-erosion resistance of high-strength concrete," *Construction and Building Materials*, vol. 21, no. 2, pp. 458-463, 2007.

