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Investigation of Fly ash Polymer Composite

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ABSTRACT

Present day squander like fly-flotsam and jetsam which is making environmental issues, is chiefly used as a design material as a result of its negligible cost and basic openness. Regardless, the major disadvantage of these squares is its low strength. Thusly, a lot of assessment is continuing to extend the strength of these squares. The current assessment work is done to encourage one more effective technique to make fly trash composite squares which will have higher compressive strength. Here the fly-trash is mixed in with Cold setting gum at different degrees and water treated at different temperatures to find a response for the square business. The compressive strength, Hardness, water ingestion, Density and warm conductivity of the fly trash sap powder blocks obtained under ideal test conditions are 11.24 MPa, 47.37HV, 19.09% 1.68 g/cm3, and 0.055 W/mK separately. The sliding wear lead is also analyzed. The plan property relationship of these composites is inspected using X-bar diffraction, FTIR assessment and actually taking a look at electron microscopy.

Keywords: Industrial waste, fly-ash, strength, proportions, thermal conductivity, Density, correlation, composite

1. INTRODUCTION

The entire improvement of a country depends upon the creation worth of power and subsequently its usage as energy. Our country, India needs gigantic power resources for meet the presumption for its inhabitant similarly as its intend to be a made country by 2020. Oil based good has a huge impact in fulfilling the requirement for impact age .Coal is seen as one of the world's generally lavish and extensively scattered non-sustainable power source. All through the planet, India overpowers the third circumstance in the greatest formation of coal and has the fourth greatest coal holds approx. (197 Billion Tons). It has been evaluated that 75% of India's outright presented power is warm of which the part of coal is about 90%. Nearly around 600 Million tons of coal is conveyed overall reliably, with Fly garbage age is around 500 MT at (60-78 %) of whole trash made [1, 2].In India, the current time of FA is nearly around 180 MT/year and is probably going to increase around 320 MT/year by 2017 and 1000MT/year by 2032 [3] .No vulnerability Indian coal has high flotsam and jetsam content and low warmth regard. To satisfy the extending testing needs, much coal based thermal power plants have been fabricated. Due to which gigantic proportion of combusted development as Fly flotsam and jetsam (80 %), and Bottom garbage (20%) has been made. The finely dissipated atom from the duplicated coal is delivered out through the line gases which are removed definitively through electrostatic precipitators and separators which are then assembled in the field of holders. The speed of making of FA is high and it keeps growing an apparently interminable measure of an enormous number of years. The yearly making of FA in China, India and US is approximated around 275 million metric tons. However, not actually half of this is eaten up in various districts. The best test before the getting ready and gathering adventures is the expulsion of the excess incidental effects. The dangerous impact on the natural variables suggests the requirement for reasonable dumping of fly garbage and legitimizes full utilization of FA when commonsense. Incidental effects that are generally toxic, ignitable, damaging or responsive have obstructing environment results. This critical issue requires a feasible, monetary and eco-obliging strategy to deal with the expulsion of the leftover mechanical results. The issue with safe evacuation of flotsam and jetsam without impacting the environment, disturbing organic balance and the gigantic amassing area required are huge issues and troubles for secured and commonsense headway of the country. Along these lines needful endeavors are being made industriously by making unyielding rules by the public position to totally utilize the trash. At present only 50% of the fly flotsam and jetsam is generally speaking beneficially utilized in India [4]. The most broadly perceived and a potential way to deal with utilizes these cutting edge wastes things is to go for improvement of roads, thoroughfares and embankments. The Problem with normal pollution can be unquestionably diminished if these wastes things be effectively utilized being developed of roads, interstates and banks. Nevertheless, sufficient proportion of soil of needed quality isn't available with no issue. So these mechanical wastes not simply used as one more for ordinary soils in the advancement rather it moreover deal with the issues of expulsion and environment tainting. This will give different basic benefits to the structure business similarly concerning the country in general by security of standard resources, by abatement of volume of waste to landfills, by cutting down the cost of advancement materials, and by cutting down trash expulsion costs. With the help of some sensible stabilizer like lime, thermosetting tars or concrete, the properties of fly garbage can be extended and it will in general be furthermore used as an advancement material. FA shows self - cementing conduct that is the explanation it is used being developed widely.

Fly Ash:

FA is an Industrial waste which is acknowledged as a natural toxin, created during the burning of coal for energy creation. At the point when the coal is terminated inside the mesh of a kettle, Carbon and volatiles materials totally consumed off. Yet at the same time, some inorganic debasements of earth components (sand, Feldspars and so on) are fortified together and are released out through pipe gases. At the point when these combined materials are permitted to cement, it brings about the development of fine and round particles called Fly debris. These FA particles are small circles encased in a major circle called plerospheres. Empty circles are likewise called cenospheres. The morphology of FA particles is circle because of the holding which happens during suspension of delivered vent gases from chimney stack or evaporator. These fine particles mostly comprise of oxides of silicon, aluminum and iron. A few components like P, Mg, K, Ca, with little hints of Cu, Zn, Mn, Fe, B, and Mo are likewise found. The properties of FA shift from various sources, from a similar source however with time and with the procedures utilized for taking care of, capacity and variety in load age [5]. Fly debris is utilized as an advantageous cementitious material (SCM) in the creation of Portland concrete cement. An advantageous cementitious material, when utilized related to Portland concrete, contributes to the properties of the solidified cement through pressure driven or pozzolanic movement, or both. Pozzolans that are normally utilized in concrete incorporate fly debris, silica seethe and an assortment of normal pozzolans, for example, calcined earth and shale, and volcanic debris. SCM's that are water driven in conduct incorporate ground granulated impact heater slag and fly cinders with high calcium substance.

Cold setting resin: -

Cold mounting compound gum is utilized as a fastener material to give entombs molecule connection between the FA particles and to expand their fortifying impact. They are acceptable protection from climatic and synthetic debasement. Gum powder can't shows its impact alone until it is blended in with hardener (or gas pedal) to give the mounting compound, and afterward the polymerization interaction happens to frame the ideal square.

METHODOLOGY

Fly debris has been utilized in different building and mechanical applications for huge scope. Consequently Consumption of this enormous measure of fly debris significantly decreases the troubles met by coal based TPPs for its unloading. Examination on the presentation of FA at different states is basically needed before its use. So to comprehend the attributes components of FA, tests can't be performed on field space. There is no any substitute choice with the exception of examination lab test to survey its significance. The exploration led in lab gives a calculative way to deal with oversee a few boundaries that go over during training.

Brief portrayal of the sorts of material utilized, example arrangement and its portrayal through SEM, XRD, and FTIR, Mechanical and surface properties like Compressive strength, Hardness and wear obstruction, Thermal conductivity estimation and others are laid out in this part.

MATERIALS USED

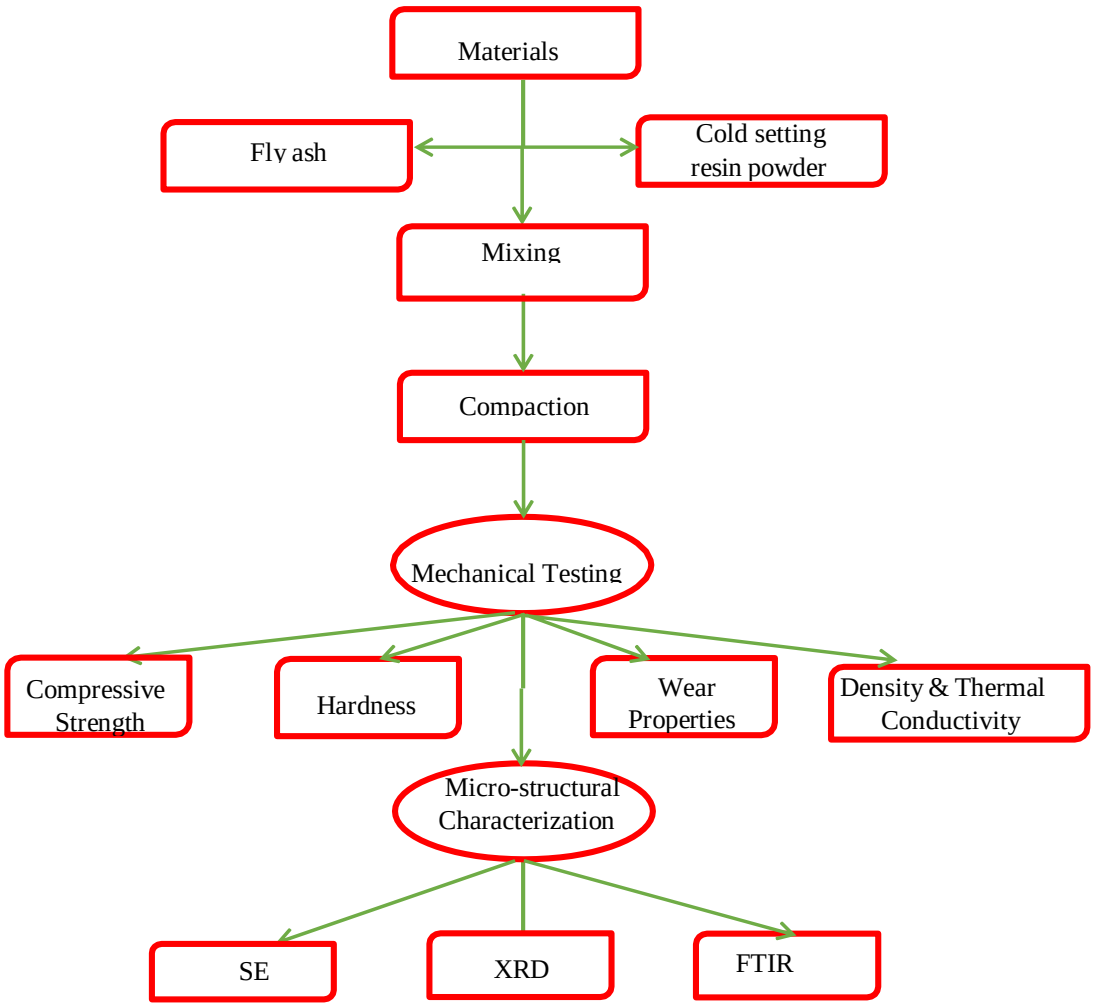
Fly ash

The Fly debris utilized in this venture was gathered from electrostatic precipitators of the hostage power plant (CPP-II) in dry condition. The fine powders were broiler dried at 110oC-160oC and kept in water/air proof container for sometime in the future. Fly debris is a result of consuming crushed coal in an electrical creating station. In particular, it is the unburned buildup that is out of control from the consuming zone in the evaporator by the pipe gases and afterward gathered by either mechanical or electrostatic separators. The heavier unburned material drops to the lower part of the heater and is named base debris; this material isn't by and large reasonable for use as a cementitious material for concrete, however is utilized in the production of substantial stone work block. Fly debris is a pozzolanic material. It is a finely-isolated formless alumino-silicate with fluctuating measures of calcium, which when blended in with portland concrete and water, will respond with the calcium hydroxide delivered by the hydration of portland concrete to create different calcium-silicate hydrates (C-S-H) and calcium-aluminate hydrates.

Cold setting Resin and Binder

The fastener serves to create foundry shape and involves an answer (ideally a fluid arrangement) of aldehyde responsive phenol substances and vaporous acetals (ideally dimethyl formal) as response accomplices and solid acids, for example sulphuric corrosive and sulphonic acids as an impetus. The acetal is in this framework hydrolysed by the corrosive, the fundamental aldehyde being shaped, which will respond with the aldehyde receptive phenol substance joined by cross-connecting. The corrosive serves in this manner at the same time as a cross-connecting impetus. On a basic level, it is feasible to see as "aldehyde responsive phenol substances" any phenolic intensifies which can in the corrosive reach cross-interface pretty much immediately with aldehydes. Ideally, these are resorcinol or resorcinol items, for example resorcinol pitch or precondensates shaped with a setback of aldehyde, for example in view of resorcinol formaldehyde, phenol resorcinol formaldehyde or resorcinol melamine formaldehyde.

Flow chart of experimental procedure



RESULTS AND DISCUSSION

Composition of Fly ash

FA mainly consists Silica (Sio2), Alumina (Al2o3), Calcium Oxide (CaO), and Iron Oxide (Fe2O3).The chemical composition of Fly ash is tabulated in table 4.1.

Table 4.1 Compositional analysis of Fly ash

Compounds	SiO_2	Al_2O_3	CaO	Mgo	P_2O_5	Fe2o3	SO_3	K_2O	LOI
Composition(%)	53.9	26.4	2.2	0.58	0.6	-	-	-	14.18

Water Absorption Test

Table 4.2 shows the amount of water absorbed corresponding to different FA composition. The water absorption values of FA composites lies in the range of 15.55 % to 19.09%. It can be seen that all the composition met the absorption criteria set by several developing countries. India permits the maximum of 20 % water absorption when compacts are immersed for 24 hours.

Table 4.2 Percentage (%) water absorbed by various FA polymer compacts

Mix Composition(Wt. %)	**Weight (gm)**		**Water Absorption(%)**	**Average Water Absorption Value(%)**
	Dry	**Wet**		
(FA)75%+ (RP)25%	4.579	5.302	15.78	15.55
	4.630	5.340	15.33	
(FA)80%+ (RP)20%	4.452	5.151	15.70	16.61
	4.642	5.456	17.53	
(FA)85%+ (RP)15%	4.502	5.356	18.96	19.09
	4.329	5.162	19.23	

It shows a relation between the amount of water absorbed and density of dry composite with respect to FA composition. It is evident from the graph that the water absorption increases with increase in FA content. 85wt. % FA absorbs water to a maximum of 19.09%. This indicates that that most of the openings of the compacts are open to outside.

Density Measurement

Density of the samples was calculated before and after treatment. From Fig. 4.2 we can say that density of dry compacts decreases with increase in weight percentage of FA. As the dry compacts are immersed in water at 110^0C -180^0C, then through capillary action voids are filled and it becomes hard and the porosity is eliminated. As a result of which the compacts become dense and finally the density increases with increase in FA content.

Table 4.3 Density value of dry and wet FA polymer compacts

Mix Composition (Wt. %)	Density (g/cm^3)	
	Dry	Wet
(FA)75%+ (RP)25%	1.42	1.61
(FA)80%+ (RP)20%	1.36	1.63
(FA)85%+ (RP)15%	1.32	1.66

Hardness Measurement

Hardness values of all the Fly ash polymer composite of different compositions, both in dry and wet state, were measured by the help of LECO, LM 248AT Vickers hardness tester. The Hardness values as obtained are shown in Table 4.4. The values of hardness are in the range of 32.93 HV – 44.08 HV for dry composites and 39.78 HV – 47.37 HV for wet FA composites respectively.

Table 4.4 Hardness values of various FA resin mix compacts

S.NO	Mix Composition (Wt. %)	Micro hardness value (HV)	
		Dry	Wet
1	(FA)75%+ (RP)25%	31.93	39.68
2	(FA)80%+ (RP)20%	37.26	43.02
3	(FA)85%+ (RP)15%	43.08	47.52

Determination of Compressive Strength

The compressive strength measurement of the cylindrical samples was done as per standard practiced. Test was conducted on the three samples of each composition and the average value of all is evaluated. Table 4.5 shows the strength values of different compositions of FA, both in dry and wet state. For dry composites, the Compressive strength value lies in the range of 6.5 to 11.28 MPa. 85 wt. % FA compositions have got the highest strength value while the lowest strength value of 6.5 MPa was gained by 75 wt. % FA composition.

Table 4.5 Compressive strength values of different FA resin mix compacts

S.NO	Mix Composition (Wt. %)	Compressive Strength (MPa)	
		Dry	Wet
1	(FA)75%+ (RP)25%	6.4	5.49
2	(FA)80%+ (RP)20%	8.83	7.96
3	(FA)85%+ (RP)15%	11.38	9.45

Thermal Conductivity measurement

Thermal Conductivity is the property of a material portraying its ability to trade heat .The Thermal Conductivity of the Fly debris – Resin Powder not set in stone through Hot wire strategy utilizing KD2 professional analyzer .It was accounted for that the conductivity of FA-gum powder blend

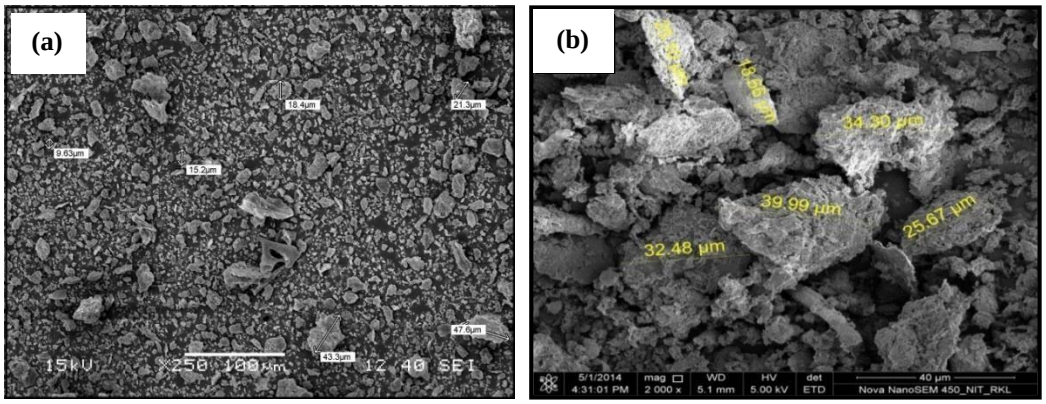
diminishes in with expansion in FA content.75 wt. % of FA organization showed the most extreme thermal conductivity esteem with a normal of 0.0552 W/mK Just FA powder shows conductivity esteem higher than other three compositions.

Microstructural study of Fly ash polymer Composite

SEM Analysis

Microstructure of the composites with 75, 80 and 85 wt. % FA plus resin powder mix was studiedby the SEM at different magnifications. Particle size of FA powder was also determined. It has been found that the particle size of FA lies in the range of 9.63- 47.6 µm.

Figure.4.11 (a, b) Particle size distribution of FA powder at different Magnification



FTIR Analysis

The Fourier changes infrared radiation (FTIR) spectrometer plot of 100 % FA alongside 80% FA + 20 % RP blend. It tends to be seen that for 80 % FA blend the (%) conveyance is getting diminished as for 100% FA .With examination of FTIR range stage change of FA and FA blend can be perceived. The most trademark contrast between the FTIR ranges of these two is the moving of band ascribed to the deviated vibrations of Si-O-Si and Al-O-Si. The broadness in band had all the earmarks of being around 1250 cm-1 in the FTIR range, which became keener when contrasted with FA blend. . Then, at that point after these groups begins moving towards low frequencies at around (950 cm-1) demonstrating the development of a gel like stage named alumina silicate which is associated with the suspension of fly debris in the solid antacid initiating arrangements. Extending vibration of Si-O-Al showed up at around 600 cm-1. The wide band bunches displayed in both IR spectra in the space of 3500 cm-1 are relegated to extending (- OH) and bowing (H-O-H) vibrations of bound water particles, which are surface devoured or entrapped in the gigantic dejections of the polymeric skeleton [30, 31]. This broadness shows the presence of solid hydrogen holding [32].

As a decision, water content is an essential combination boundary that influences their mechanical strength. Pinnacles showed up around 2400 cm-1 ascribed to O-H extending. The slow decrement in the force and broadness in the band affirms the deficiency of water. Top at 3000 cm−1 – 2000 cm-1 could be allocated to C-H extending vibration of natural toxins which might be presented during test taking care of or some hydrocarbon present in fly debris [33].

XRD Analysis

The XRD investigation of water treated compacts. It has been tracked down that within the sight of dampness, pozzolanic response happens that prompts the arrangement of new stage for example calcium silicate hydrate (CSH) and calcium aluminates silicate hydrate (CASH) .These stages are liable for cementing of unfired compacts and subsequently making solid constructions, incredible entomb molecule holding with further developed mechanical properties like hardness and so on CSH and CASH are viewed as an underlying response item which changes in to a semi glasslike strong stage called Tobermorite (C5S6H5).

CONCLUSION

Based on present investigation following end can be drawn:

1. Water treated compacts shows constructive outcomes on the hardness esteems. Out of every dry smaller, FA with 85 wt. % has a higher hardness worth of 44.08 HV. Much improvement in the hardness esteem is accomplished when the composites are treated in water at 1100-1800C and this worth rose to 47.37 HV. This augmentation in hardness esteem is because of the presence of CSH and CASH within the sight of dampness as acquired from XRD investigation.
2. With an expansion in polymer expansion (pitch powder), the compressive strength of dry compacts diminishes to a lower worth of 6.5 MPa. Structure of 75 wt. % FA shows lower esteem. No huge decrease in Compressive strength is accomplished on account of wet smaller.
3. Wear investigation of various composites can without much of a stretch be associated with the hardness esteem. In both the dry and wet state, FA with 85 wt. % creation shows preferred protection from wear over other two organizations. Wear obstruction increments with expansion in FA content. The co-effective of grinding diminishes with expansion in FA rate and pursues a straight direction for the duration of the trying period.
4. Thermal conductivity of FA increments with expansion in temperature, though if there should be an occurrence of sap powder FA blends, the conductivity of composite reductions with expansion in temperature. A much lower conductivity esteem is gotten and consequently can be utilized as a substitute material concerning dirt.
5. Water retention increments with expansion in FA content. Limit of 19% water is caught up in the event of 85 wt. % FA.
6. Density of dry compacts diminishes with expansion in FA content. While if there should arise an occurrence of wet compacts, it increments with

expansion in FA content.

7. SEM investigation uncovered the morphology of FA particles that are for the most part round fit. With decline in polymer expansion for example expansion in FA content the interface holding turns out to be better and less measure of breaks were found at the interfaces.
8. XRD investigation uncovered that FA particles for the most part comprise of Silica and alumina with less level of Fe2O3, Cao and others.

The Fly debris – tar powder composite created in the current examination appear to be proper for use as development material. The creation of this sort of composite will unquestionably add to the utilization of fly debris for esteem added items. Then again, the decrease in earth utilization for the creation of traditional dirt blocks will assist with securing the climate.

REFERENCES

[1] Joshi RC, Lothia RP. Fly ash in concrete: production, properties and uses. In: Advances in concrete technology, vol. 2. Gordon and Breach Science Publishers; 1999

[2] Ahmaruzzaman M. A review on the utilization of fly ash. Prog Energy Combust 2010; 36:327–63.

[3] Rai A.K., Paul B. and Singh G., A study on physico chemical properties of overburden dump materials from selected coal mining areas of Jharia coalfields, Jharkhand, India, Int.Journal of Environmental Sc., 1 (2011): pp. 1350-1360.

[4] Sahay A.N., R&D initiatives in utilization of fly ash in coal sector, in: Proc. of Fly ash an opportunity for Mining Sector, New Delhi, India, 2010, pp. 26-35.

[5] Das S.K. and Yudhbir, Geotechnical properties of low calcium and high calcium fly ash, Journal of Geotechnical and Geological Engineering, 24 (2006): pp. 249-263

[6] Sinsiri T, Chindaprasirt P, Jaturapitakkul Ch. Influence of fly ash fineness and shape on the porosity and permeability of blended cement pastes. Int J Miner Metal Mat 2010; 17:683-690**.**

[7] P.S.M. Tripathy, S.N. Mukherjee, Perspectives on Bulk Use of Fly Ash, CFRI Golden Jubilee Monograph, Allied Publishers Limited, 1997, p. 123.

[8] Sidhu, Buta Singh, Singh, Harpreet, Puri D., Prakash, S., "Wear and Oxidation Behavior of Shrouded Plasma Sprayed Fly ash Coatings", Tribology International, Volume 40, (2007), pp.800-808.

[9] China Economic Trade Committee, Tenth five-year program of building materials industry,China Building Materials 7, 2001, pp. 7–10

[10] P. Wouter, Energy Performance of Building: Assessment of Innovative Technologies, ENPER-TEBUC, Final Report, 2004

[11] M. Anderson, G. Jackson, The history of pulverized fuel ash in brick making in Britain, J.Inst. Ceram. 86 (4) (1987) 99–135.

[12] M. Anderson, G. Jackson, The beneficiation of power station coal ash and its use in heavyclay ceramics, Trans. J. Br. Ceram. Soc. 82 (2) (1983) 50–55.

[13] Pofale and Deo, 2010; Kumar, 2000; Reddy and Gourav, 2011; Dry et el., 2004; Mitraetal., 2010).

[14] Shenbaga, R. Kaniraj and V. Gayathri (2004), "Permeability and Consolidation Characteristics of Compacted Fly Ash", Journal of Energy Engineering. ASCE, Vol. 130,117-211

[15] ASTM C 618-08a (2008) Standard specification for coal fly ash and raw or calcined naturalpozzolan for use in concrete, American Society for Testing and Materials

[16] ASTM C 618-08a (2008) Standard specification for coal fly ash and raw or calcined naturalpozzolan for use in concrete, American Society for Testing and Materials.

[17] Jala S, Goyal D. Fly ash as a soil ameliorant for improving crop production – a review. Bioresour Technol 2006; 97(9):1136–47.

[18] Sikka R, Kansal BD. Characterization of thermal power-plant fly ash for agronomic purposes and identify pollution hazards. Bioresour Technol 1994; 50:269–73

[19] Matsi T, Keramidas VZ. Fly ash application on two acid soils and its effect on soil salinity, pH, B, P and on ryegrass growth and composition. Environ Pollut 1999; 104(1):107–12

[20] http://flyashindia.com/properties.htm.

[21] Roy WR, Thierry RG, Schuller RM, Suloway JJ. Coal fly ash: a review of the literature and proposed classification system with emphasis on environmental impacts. Environmental geology notes 96. Champaign, IL: Illinois tate Geological Survey; 1981.

[22] Tolle DA, Arthur MF, Pomeroy SE. Fly ash use for agriculture and land reclamation: a critical literature review and identification of additional research needs. RP-1224-5. Columbus. Ohio: Battelle Columbus Laboratories; 1982.

[23] Mattigod SV, Dhanpat R, Eary LE, Ainsworth CC. Geochemical factors controlling the mobilization of inorganic constituents from fossil fuel combustion residues: I. Review of the major elements. Journal of Environmental Quality 1990;19:188–201

[24] Da Costa JCD, Prasad P, Pagan RJ. Modern environmental improvement pathways for the coal power generation industry in Australia. Process Safe Environ Protect 2004; 82(3B):191–9.

[25] Matsi T, Keramidas VZ. Fly ash application on two acid soils and its effect on soil salinity, pH, B, P and on ryegrass growth and composition. Environ Pollut 1999; 104(1):107–12.

[26] Pandey VC, Singh N. Impact of fly ash incorporation in soil systems. Agric, Ecosys Environ 2010; 136(1 2):16 27.

[27] Pujari GK, Dash PM. Fly ash – problem and management aspect. Envis Newsl Centre Environ Stud 2006; 3(1):1–8.

[28] ASTM Standard D5334-08 – Standard Test Method for Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure, doi:10.1520/D5334-08

[29] Chapman TR, Niesz DE, Foxrt, Fawcett T. Wear 1999;236:81

[30] Swanepoel J.C., Strydom C.A.: Utilization of fly ash in a geopolymeric material, AppliedGeochemistry, vol. 17, pp. 1143-1148, (2002).

[31] Fernandez-Jimenez A., Palomo A, Composition and microstructure of alkali activated fly ash binder: Effect of the activator. Cement and Concrete Research, vol. 35, pp. 1984-1992,(2005).

[32] Khatri C, Rani A. Synthesis of a nano-crystalline solid acid catalyst from fly ash and its catalytic performance. Fuel. 2008; 87(13):2886–92. doi:10.1016/j.fuel.2008.04.011.

[33] Saikia BJ, Parthasarthy G, Sarmah NC, Baruah GD. Fourier-transform infrared spectroscopic characterization of naturally occurring glassy fulgurites. Bull Mater Sci. 2008; 31(2):155–58.