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Evaluation of Fly Ash Composite Polymer

Mayur Solanki, Nitesh Rane

PG Scholar, MED, Dr. APJ Abdul Kalam University Indore, M.P., India

Assistant Professor, MED, Dr. APJ Abdul Kalam University Indore, M.P., India

ABSTRACT

Because it is inexpensive and readily available, industrial waste like fly ash, which is causing environmental issues, is largely employed as a building material. However, the primary drawback of these bricks is their lack of strength. Thus, there is a great deal of research being done to make these bricks stronger. The goal of the current research project is to create a novel, methodical process for making fly ash composite bricks with increased compressive strength. To discover a solution for the brick industry, fly ash is combined with cold setting resin in various ratios and water treated at various temperatures. Under ideal test conditions, the fly ash-resin powder bricks had compressive strength, hardness, water absorption, density, and thermal conductivity of 11.24.MPa, 47.37HV, 19.09% 1.68 g/cm3, and 0.055 W/mK respectively. The sliding wear behavior is also investigated. The structure-property correlations of these composites are studied using X-ray diffraction, FTIR analysis and scanning electron microscopy.

Key Words: Fly-Ash, Building Material, Compressive Strength, Resin Powder, Bricks

INTRODUCTION

The production value of electricity and, by extension, its consumption as energy, determine a nation's whole development. In order to meet the expectations of its citizens and achieve its goal of being a developed nation by 2020, our country, India, need enormous power resources. In order to meet the need for power generation, fossil fuels are crucial.One of the wealthiest and most abundant fossil fuels in the planet is coal. India ranks third globally in terms of coal output and possesses the fourth-largest coal reserves, with an approximate total of 197 billion tons. According to estimates, 75% of India's installed power is thermal, with coal accounting for over 90% of this total. Approximately 600 million tons of coal is produced worldwide every year, with Fly ash generation is about 500 MT at (60-78 %) of whole ash produced [1, 2].In India, the current generation of FA is nearly about 180 MT/year and is probable to increase about 320 MT/year by 2017 and 1000MT/year by 2032 [3] . Indian coal undoubtedly has a poor heat value and a high ash content. An rising number of coal-based thermal power plants have been built to fulfill the demanding demands. This led to the production of a massive amount of burned residue in the form of fly ash (80%) and bottom ash (20%). The burned coal's finely divided particles are released into the flue gases, which are mechanically separated from one another by separators and electrostatic precipitators before being gathered in hopper fields. The production rate of FA is significant and continues to rise annually. Indian coal undoubtedly has a poor heat value and a high ash content. An rising number of coal-based thermal power plants have been built to fulfill the demanding demands. This led to the production of a massive amount of burned residue in the form of fly ash (80%) and bottom ash (20%). The flue gases from the burned coal release the finely divided particles, which are mechanically separated by electrostatic precipitators. The United States, China, and India together produce over 275 million metric tons of FA annually. However, only about half of this is consumed nationwide. The largest issue facing the manufacturing and processing sectors is how to properly dispose of leftover garbage. The detrimental effect. Waste products that are generally toxic, ignitable, corrosive or reactive have detrimental environment consequences. This major issue requires an effective, economic and eco- friendly method to tackle with the disposal of the residual industrial waste products. The problem with safe disposal of ash without affecting the environment, disturbing ecological balance and the large storage area required are major issues and challenges for safe and sustainable development of the country. Hence needful efforts are being made continuously by making stringent regulations by the government to fully utilize the ash. Currently only 50% of the fly ash is being profitably utilized in India [4]. The most common and feasible ways to utilize these industrial wastes products is to go for construction of roads, highways and embankments. The Problem with environmental

If these waste products are efficiently used in the building of roads, highways, and embankments, pollution can be significantly decreased. However, it is difficult to get enough soil of the right quality in significant quantities. Therefore, these industrial wastes not only serve as a substitute for natural soils in building, but they also provide a solution to the disposal and environmental pollution issues. This will save natural resources, reduce the amount of trash going to landfills, cut the cost of building materials, and save waste disposal expenses, all of which will have a major positive impact on the construction sector and the nation as a whole. With the help of some suitable stabilizer like lime, thermosetting resins or cement, the properties of fly ash can be increased and it can be further used as a construction material. FA shows self -hardening behavior that is why it is used in construction broadly.

FLY ASH: AN OVERVIEW

FA is an industrial waste that is produced when coal is burned to provide energy and is recognized as a pollutant to the environment. Carbon and volatile elements entirely burn off when coal is heated inside a boiler's grate. Nevertheless, some inorganic impurities of earthly materials, such as feldspar and sand, are bound together and released through flue gases. Fly ash, which are tiny, spherical particles, are created when these fused materials are allowed to solidify. These FA particles are microscopic spheres encased in plerospheres, which are large spheres. Cenospheres are another name for hollow spheres. Because of the bonding that occurs during the suspension of discharged flue gases from the boiler or chimney, FA particles have a spherical morphology. These tiny particles are mostly made up of iron, aluminum, and silicon oxides. There are also trace amounts of Cu, Zn, Mn, Fe, B, and Mo in addition to a few elements including P, Mg, K, and Ca. The characteristics of FA varies between sources, within the same source over time, and depending on the methods employed for processing, storing, and varying load creation.

OBJECTIVE OF THE WORK

The aim of the present work is to fabricate Fly ash polymer composite at different proportions of polymer and to study physico mechanical, thermal conductivity and wear behavior. In present project an attempt was made to increase the density and hardness of the water cured cylindrical samples. SEM, XRD and FTIR analysis were also done to investigate the microstructural changes.

Result-

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.

	SiO_2	Al_2O_3	CaO	Mgo	P_2O_5	Fe2o3	SO_3	K_2O	LOI
Composition (%)	54.5	26.5	2.1	0.57	0.6	-	-	-	14.18

Table 1 Compositional analysis of Fly ash

Water Absorption Test

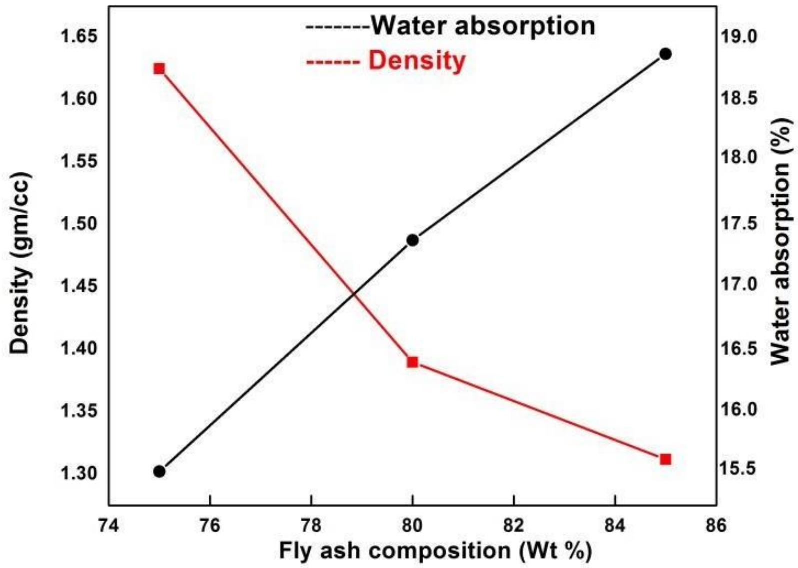


Figure.4.1 Water absorption and density as a function of FA Composition

Density Measurement

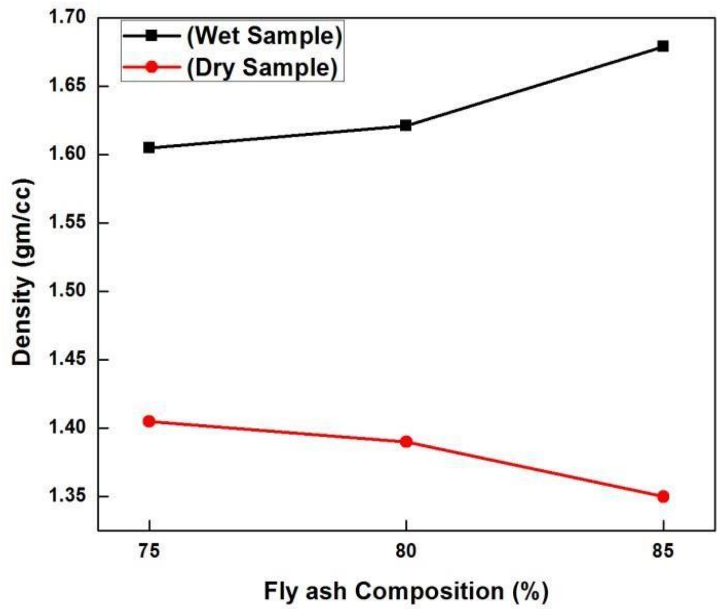


Fig.2 Variation in dry and wet density w.r.t FA composition

Mix Composition (Wt. %)	Density (g/cm^3)	
	Dry	Wet
$(FA)_{75\%}$+ $(RP)_{25\%}$	1.40	1.60
$(FA)_{80\%}$+ $(RP)_{20\%}$	1.38	1.62
$(FA)_{85\%}$+ $(RP)_{15\%}$	1.35	1.67

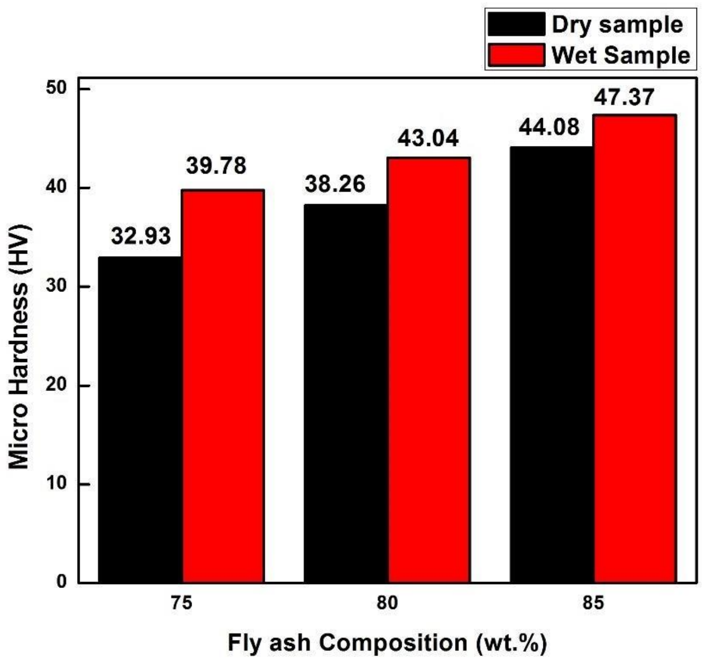
Table 3 Density value of dry and wet FA polymer compacts

Hardness Measurement

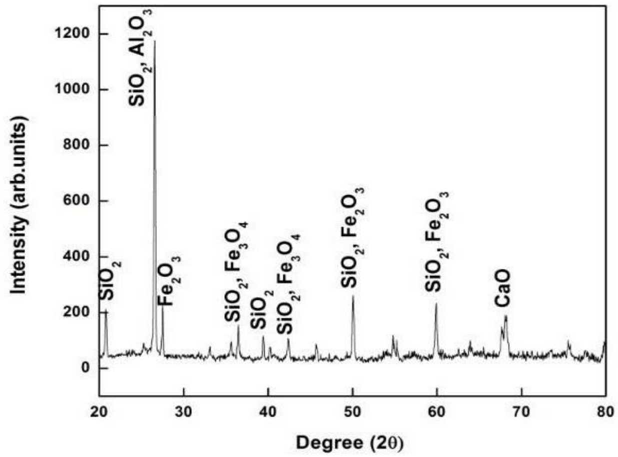
S. NO	Mix Composition (Wt. %)	Micro hardness value (HV)	
		Dry	Wet
1	$(FA)_{75\%}$+ $(RP)_{25\%}$	32.93	39.78
2	$(FA)_{80\%}$+ $(RP)_{20\%}$	38.26	43.04
3	$(FA)_{85\%}$+ $(RP)_{15\%}$	44.08	47.37

Table 4 Hardness values of various FA resin mix compacts

Fig. 3 Variation in hardness values with wt. % of FA



XRD Analysis



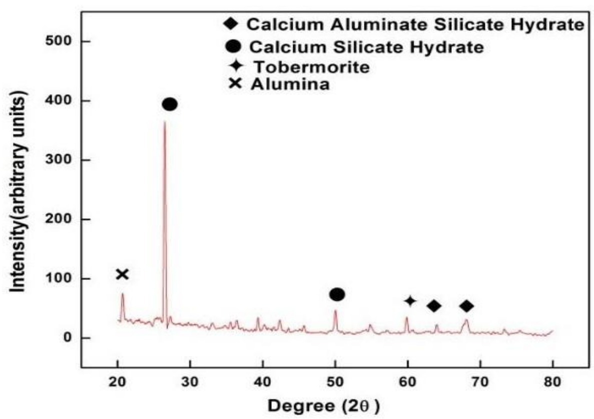


Fig.4 (a) XRD analysis of Fly ash and Fig.4.4 (b) XRD analysis of water cured compact

FTIR Analysis

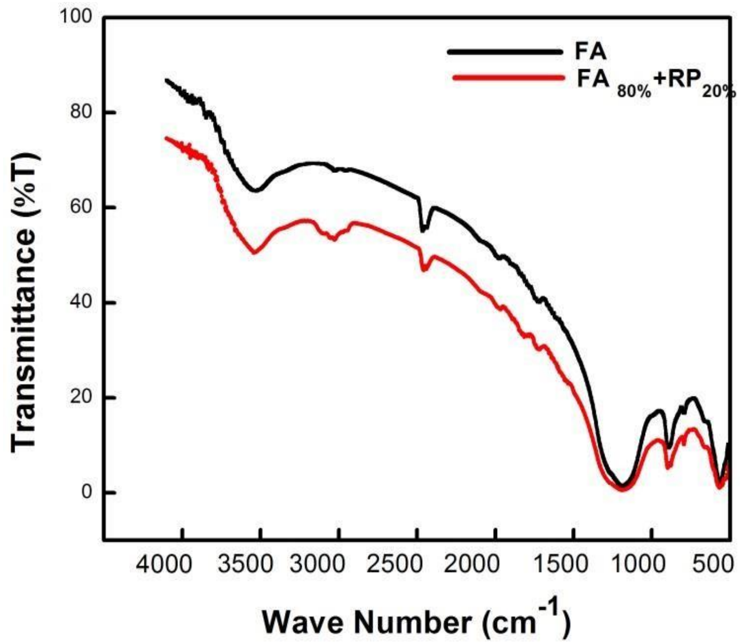


Fig.5 IR spectra of the FA and FA resin Powder mix

Determination of Compressive Strength

S. NO	Mix Composition (Wt. %)	Compressive Strength (MPa)	
		Dry	Wet
1	$(FA)_{75\%}+(RP)_{25\%}$	6.5	5.52
2	$(FA)_{80\%}+(RP)_{20\%}$	8.73	7.98
3	$(FA)_{85\%}+(RP)_{15\%}$	11.28	9.43

Table 5 Compressive strength values of different FA resin mix compacts

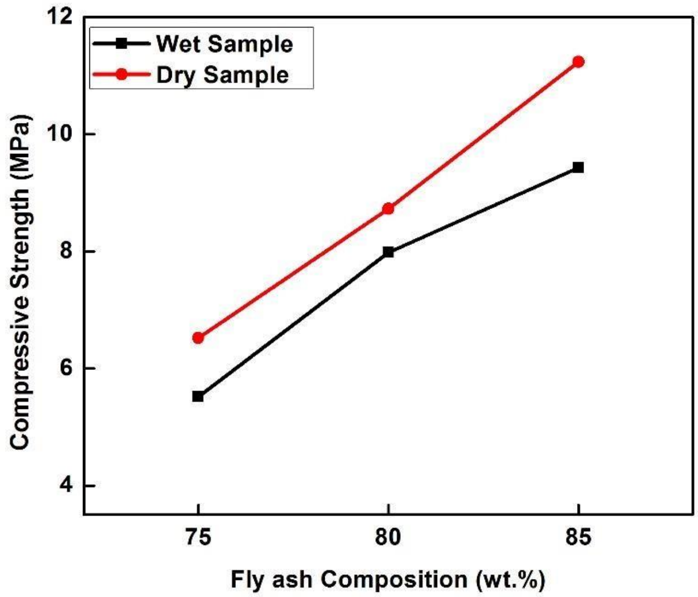


Fig.6 Compressive Strength of Compacts at different FA compositions

Thermal Conductivity measurement

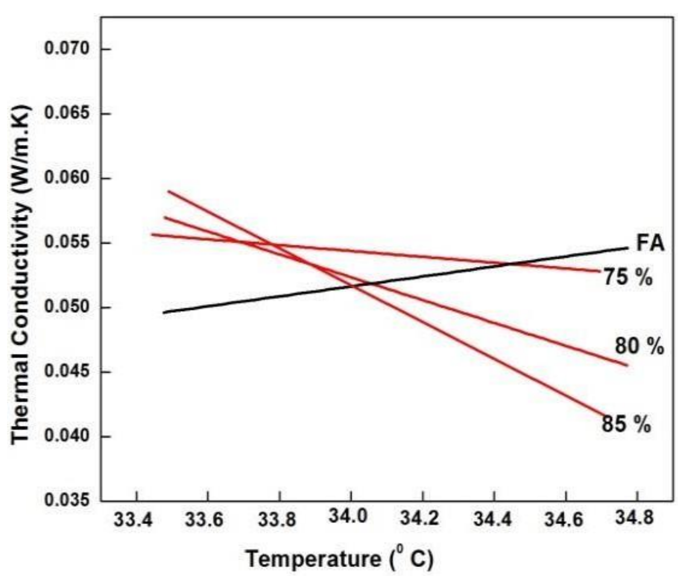


Fig.4.7 Thermal conductivity of FA –Resin powder Mix at different compositions

Wear Study

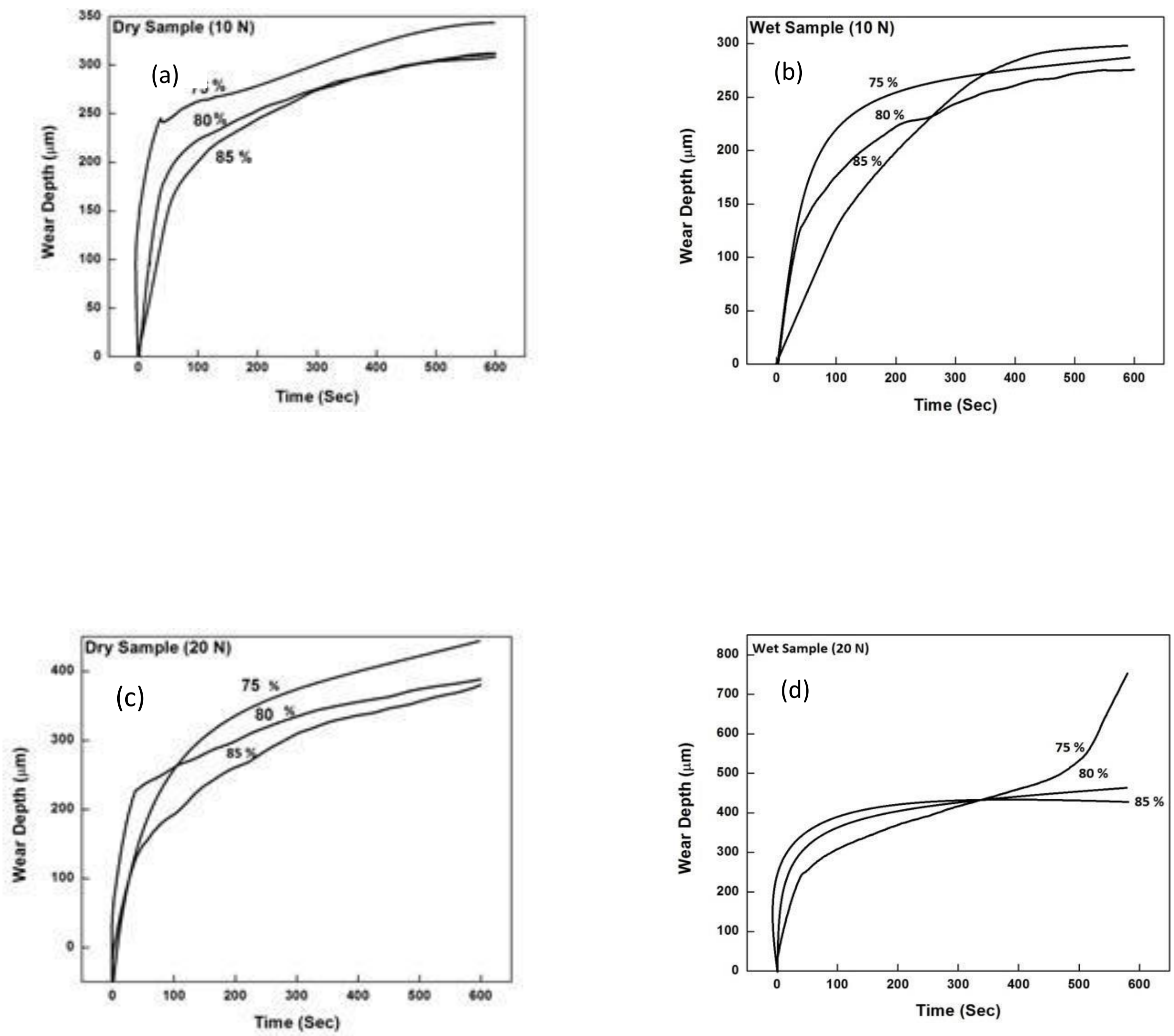
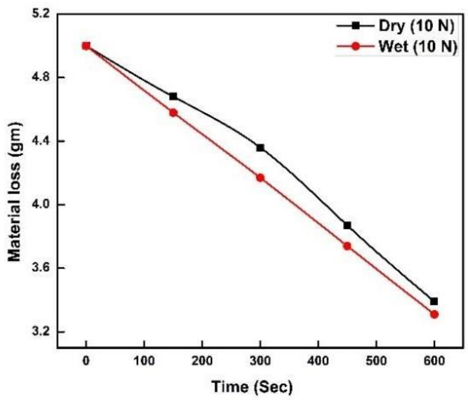


Figure 8 Wear behavior of FA compacts at different loads



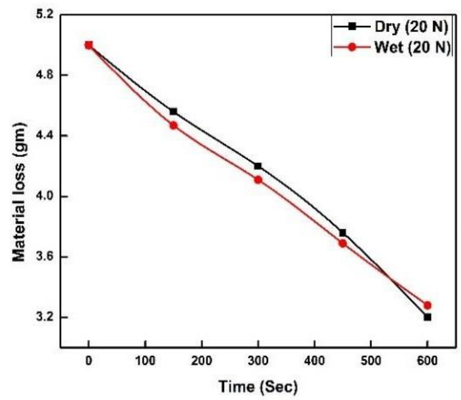
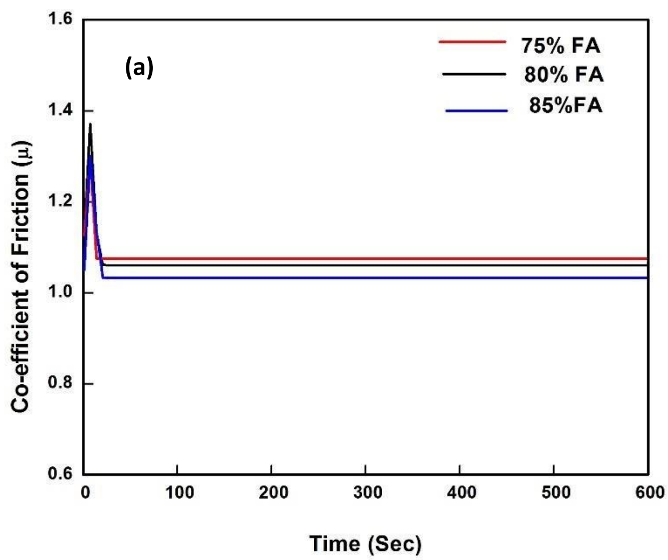


Fig.9 (a & b) shows the variation in weight loss (gm) with respect to time (sec).

Friction Study



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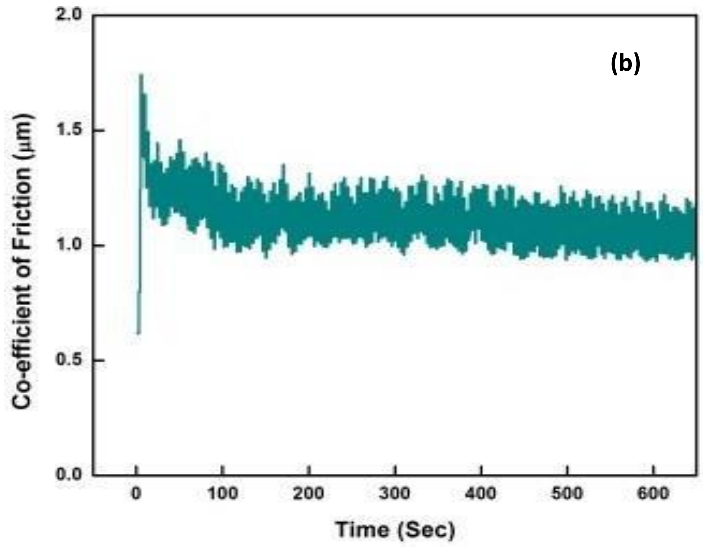

Fig.10 (a, b) Variation in co-efficient of friction w.r.t FA composition

SEM Analysis

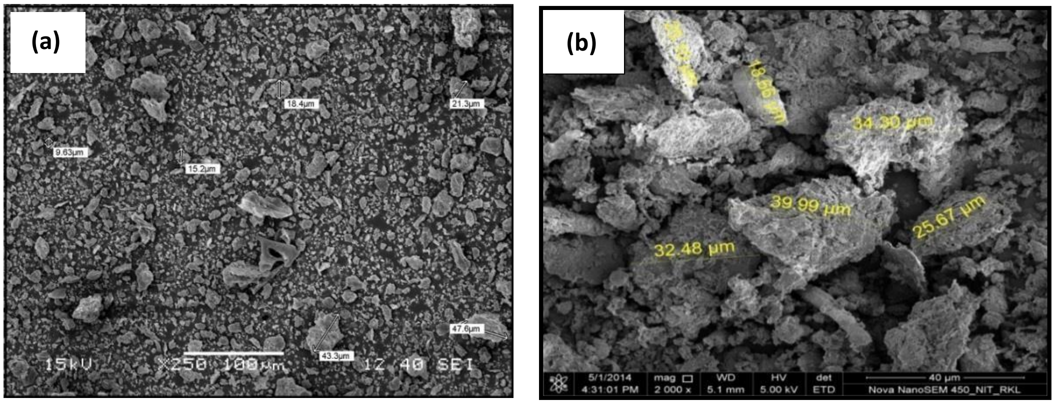

Figure.4.11 (a, b) Particle size distribution of FA powder at different Magnification

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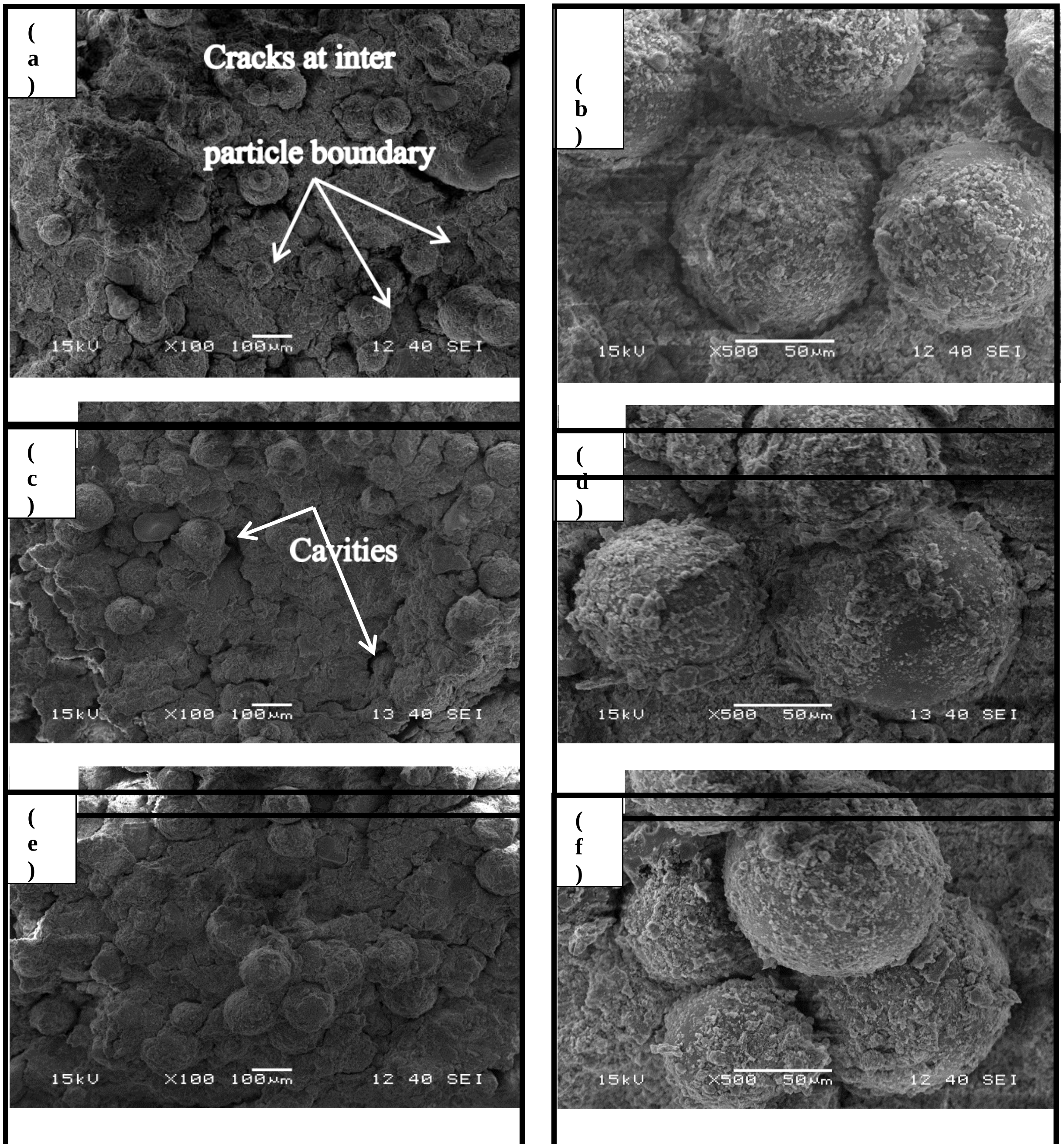

Fig.12 Morphology of Fly ash compacts with different composition and at different magnifications

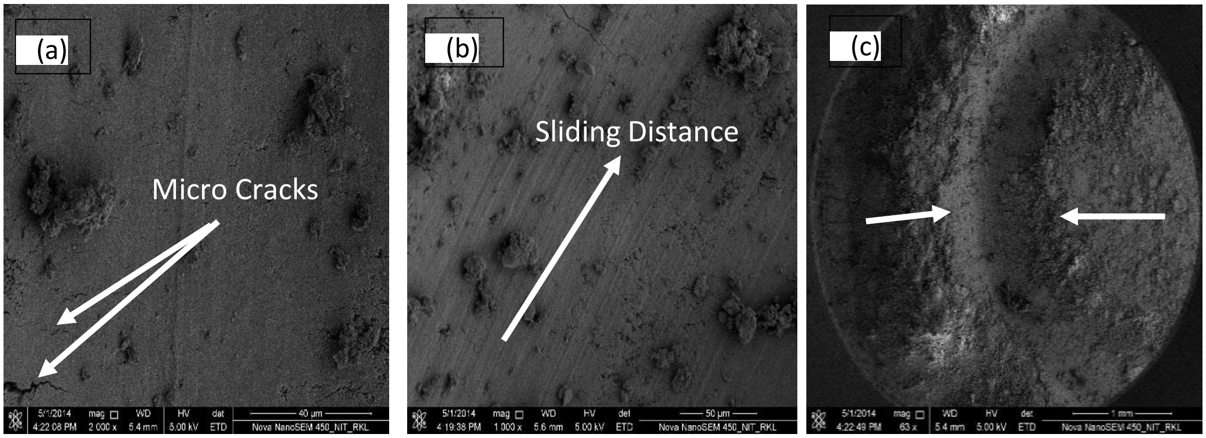

Fig. 4.13 FESEM image of wear track at different magnification

RESULT:-

It appears that the fly ash-resin powder composite made in this study is suitable for usage as a building material. The utilization of fly ash for value-added products will undoubtedly increase with the production of this kind of composite. Conversely, the environment will be better protected if less clay is used to make traditional clay bricks.

CONCLUSIONS :-

On the basis of present study following conclusion can be drawn:

1) 1) The hardness levels of compacts treated with water indicate favorable benefits. FA with 85 weight percent has the highest hardness value of 44.08 HV among all dry compacts. When the composites are treated in water at 1110–1800C, a significant improvement in the hardness value is obtained; this value increased to 47.37 HV. According to XRD research, the presence of CSH and CASH in the presence of moisture is what caused the hardness value to increase..
2) 2) The compressive strength of dry compacts drops to 6.5 MPa as the amount of polymer (resin powder) is increased. A composition of 75% FA demonstrates a lower value. Wet compact results in no appreciable decrease in compressive strength.

3) 3) The hardness value and wear studies of various composites are easily connected. FA with an 85% weight percentage exhibits superior wear resistance compared to the other two compositions in both dry and wet conditions. As the FA content rises, wear resistance rises as well. Throughout the testing period, the co-efficient of friction exhibits a linear pattern and declines as the FA percentage rises.
4) 4) Thermoconductive properties of FA increase as temperature rises, but the conductivity of composites made from resin powder FA mixes diminishes as temperature rises. It yields a substantially lower conductivity value, making it suitable for use as a clay alternative..
5) Water absorption increases with increase in FA content. Maximum of 19% water is absorbed in case of 85 wt. % FA.
6) Density of dry compacts decreases with increase in FA content. While in case of wet compacts, it increases with increase in FA content.
7) The morphology of the mostly spherical FA particles was revealed by SEM analysis. The interface bonding improves and fewer cracks were discovered at the interfaces with a decrease in polymer addition, or an increase in FA content.

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