International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-8 Issue-8 June, 2019

An Experimental Research on the Strength Characteristics of Concrete with Ground Nut Shell Ash, Fly Ash and Coconut Shell Ashas Partial Replacement of Cement

Vijay Kumar, Prince Sharma

Abstract: ***Today, green building is an essential part of ensuring sustainability, and concrete composites with siliceous fly ash (FA), coconut shell ash and ground nut ash. It results in sustainable and green concrete. In order to minimize the environmental threats caused by FA, coconut shell and ground nut waste disposal has been reduced cement consumption, it is necessary to effectively promote green concrete containing ash. In this paper, Fly ash, coconut ash, ground nut ash is generated by burning and grinding coal, coconut shell and groundnut shell respectively. The ash is mixed with cement in different proportion and the sample of cube and beam is prepared. The test such as compressive strength is measured on the cube, whereas, the flexural strength is measured on beam. Other tests such as Rebound Hammer, water absorption test and Ultrasonic Pulse Velocity Test are conducted. From the experiment, it has been analyzed that the percentage increase in the compressive strength after adding the ashes compared to the normal concrete of 8.19 % is obtained..***

Index Terms**: *Fly Ash, Coconut shell ash, groundnut shell ash, compressive strength, Rebound Hammer, and Ultrasonic Pulse Velocity Test.***

I. INTRODUCTION

Concrete is the most widely used building material. In spite of its adaptability in construction, the concrete material has many limitations. The tensile strength of concrete, ductility and the capacity to resist cracks is very small. Based on ongoing research on a global scale, various modifications have been made from time to time to overcome the inadequacies of cement concrete [1]. Ongoing research in this area, the development of concrete technology has led to the development of special concrete considering the construction speed, the strength of the concrete, durability and environmental friendliness of concrete along with fly ash, blast furnace slag, silicon powder and other industrial raw materials [2].

The use of concrete and its adaptation to the environment is practicable for almost all civil engineering and construction structures [3].To gain carbon credit and save energy is crucial for the development of humanity. To produce cement, the natural resources such as limestone, clay, chalk and so on are used, which released carbon-dioxide (CO_2) into the atmosphere and results in environmental pollution which in turns harm human life[4]. In developing countries such as India, China energy plays an important role. Building materials such as cement can be used to save both energy and the environment by gaining carbon credits using agricultural wastes such as groundnut ash, fly ash and coconut shell ash [5]. Concrete cement consists of aggregates (generally aggregates of crushed stone, gravel and limestone, plus fine aggregates from river sand), water and/or mixtures. Concrete is made by mixing cement, water. Mixing; gives strength and endurance to this goal [6]. Concrete is one of the most popular materials used in construction. When equipped with steel, it has a higher capacity to bear loads. Most of the cement used in the construction industry is ordinary Portland cement (OPC). It is produced by a mixture of naturally occurring chemical ingredients [7]. In many applications of the modern structure, the demand for structured lightweight concrete is increasing, this is due to its advantages such as low-density nature of lightweight concrete helps to load bearing as well as decrease the foundation size[8]. The natural resources are the main source of lightweight concrete.Taking into account the worldwide sustainable development, it is necessary to use supplementary cementing materials in the concrete industry instead of cement. The most commonly used supplementary cement materials available all over the world are such as silica fume, FA, coconut shell ash (CNSA), ground nut shell (GNSA)and many more [9].At present around 600 million tons of FA is available worldwide, but currently, the FA's use in concrete is around 10%. The FA has grown dramatically due to rapid economic growth and increased world energy consumption. Air and environment pollution has become a problem, so the idea of using waste material has become popular. FA is one of the most common concrete ingredients for their characteristics of pozzolanic [10]. In this research work, we are using fly ash, coconut shell ash and groundnut shell ash as a partial replacement of concrete to enhance the strength of the concrete. The detail description of different materials is given in section 3.

Revised Manuscript Received on June 07, 2019.

Vijay Kumar, Student of M.E Civil Structural Engineering, Chandigarh University, Punjab India

Prince Sharma, Assistant Professor Department of Civil Engineering, Chanigarh University, Punjab India

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

II. LITRATURE REVIEW

Tufail et al. (11, 2017) have investigated the influence of high temperature on limestone, concrete as well as quartzite properties. The prepared specimen has been exposed to a temperature ranges from 25-650 °C for 2 hours. The effectiveness has been analyzed on the basis of Compressive strength, flexible strength and modulus of elasticity. It has been analyzed that the mechanical properties of concrete are greatly affected by the change in temperature.

Nath et al. (12, 2018) have added fly ash as a partial replacement of cement in concrete for seaport building. The presented work has offered different advantages in terms of environment, durability by utilizing the waste resources effectively. From the test, it has been observed that by replacing 40 % of cement by FA, the lifetime of the structure has been increased by 1.75 times compared to traditional concrete. Also, the carbon footprint has been reduced by 22.1 % and 21.9% for FA30 and FA40 respectively.

Nwofor et al. (13, 2012) have utilized ground shell ash collected from Kano state, in Nigeria, which is the main groundnut producer in Northen Nigeria. The groundnut ash has been produced using the electric heater at temperature of 500°C to 600 °C at least 4 hr and ground nut ash has been obtained. Adebakin et al. (14, 2019) have performed an experiment by mixing coconut shell ash with fly ash and determined the efficiency in terms of different parameters. The replacement of cement has been done in 15% and 20% respectively. Mandal et al. (15, 2018) have investigated the physical characteristics of reinforced concrete integrated with coconut fibre. The coarse aggregate has been replaced with the coconut shell ash. In this research, the M20 concrete has been designed as per the American Concrete Institute (ASI) and the replacement of aggregate with the coconut shell ash has been done by percentage in 6,8,10,12 and 14.

III. MATERIALS

The materials used in this study were groundnut shell ash (GNSA), ordinary Portland cement (OPC 53 grade), sand as fine aggregates, chippings as coarse aggregates (20 mm size), and water.

A. Groundnut shell Ash

In this research,GNSA is used as partial replacement of cement. The shell of groundnut is utilized as a fuel in sweet industries as well as in the oil mills. After being utilized as a fuel, the remaining ash is used as a partial replacement of cement[16]. If the Ash is not used, it becomes the cause of major hassle.This, in turn, results in a decline in carbon emissions and effective utilization of waste.With the use of GNSA in concrete, costs will decrease and reduce environmental pollution and save energy. GNSA has better pozzolanic and chemical properties.Adding the GNSA to cement concrete can decrease the shrinkage of structure, the absorption of water, with increased settling time.The presence of GNSA can block the existing porosity of the concrete, thereby increasing its strength and sealability. The main goal is to find a solution to reduce environmental pollution due to cement production[17].

Figure 1 Groundnut shell Ash

B. Fly Ash

Fly ash may be the main producer of greenhouse emissions, thus reducing emissions of housegas. It is observed that 1 Ton of cement production in Portland generates 0.87 tone's of greenhouse gas around it. Therefore, the usages of fly ash lessen C(emissionby minimizing the rate of cement in the cement[18].

Figure 2: Fly Ash

Coal is an integral part of the herbal substance under millions of years of pressure with an erratic chemical composition. In addition, electricity companies optimize coal production by utilizing additives such as flue gas conditioners, sodium sulphate, oil and other additives to control corrosion, emission and pollution. The resultantFA comprises of different composition and may contain several additives as well as products with incomplete combustion. Mostly theFAs are pozzolanic, ieconsists of silicon or silicon withaluminium material, which forms cement after reacting with calcium hydroxide. When Portland cement reacts with water, it generates a hydrated calcium silicate and lime. It develops moisturized silicate power and fills the lime gaps [19].

C. Coconut Shell Ash

Natural materials, such as Coconut Shell, are often not used in the construction field, but still poured often as agricultural waste. However, various proposals have been made to reduce the cost of conventional building materials for developing countries for both rural and urban countries.

One of the most important proposals was to acquire, develop, and use an alternative, non-constructive local building materials, including some agricultural waste as a building material [20]. Coconut is grown in more than 90 countries. India is the third largest country, with about 1.8 million hectares of coconut production, with a production of about 10,560,000 tons Coconut. At the same time, this is a major contributor to the nation's pollution problem as solid waste. These wastes can be used indoors, either in concrete production or in small quantities or in cement [21].

Figure 3: Coconut Shell Ash

The existing research in which CSA has been used as a partial replacement of cement shows that it can be used as a partial replacement of cement. It has also been found that amorphous silicon has been found in some pozzolanic materials that react with lime much easier than those of lime. The use of such powder can lead to increased compression and bending strength. The raw material used for cement production consists mainly of lime, silica, alumina and iron oxide. In general, the chemical analysis of the Shell ash of the coconut contains some of these elements. Thus, the coconut shells can be utilized effectively as additional cementation materials.

IV. RESULT AND ANALYSIS

The efficiency of the work has been analyzed by measuring the different parameters such as compressive strength, water absorption, Flexural test, Rebond hammer, and Ultrasonic pulse velocity test.

A. Compressive Strength

The compressive strength has been measured at two intervals such as after 7 days and 28 days. The compressive strength of the prepared sample is determined as the rate of maximum load applied to the sample with respect to the samples cross-sectional area. It is measured in N/mm^2.The Compressive strength measured for six samples prepared by mixing material in different Proportion of Cement: Fly Ash: Coconut Ash: Ground Nut Ash is listed in table 1.

Table 1: Cubes preparation Content Percentage

Mix	Coconut shell Ash (%)	Groundnut shell Ash (%)	Fly Ash (%)
M0	0	0	0
M1	10	10	10
M2	10	10	20
M3	10	20	10
M4	10	10	30
M5	10	20	20
M6	10	20	30

Table 2: Compressive Strength

Number of Samples	After 7 days (N/mm^2)	After 28 days (N/mm^2)
M0	21.60	32.24
M1	19.71	29.42
M2	22.93	34.23
M3	23.37	34.88
M4	21.08	31.47
M5	20.92	31.22
M6	19.27	28.76

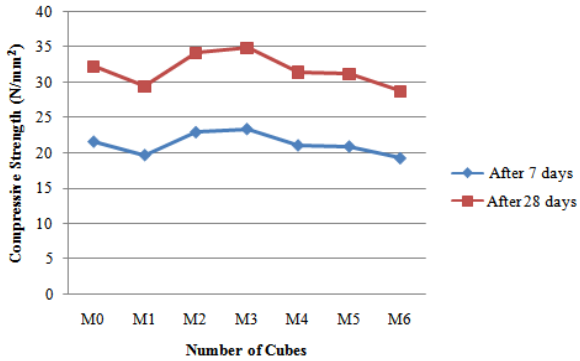

Figure 4: Compressive Strength

The cube of size 150×150×150 is prepared as per the code IS 516:1959. From the figure,it has been analyzed that the average compressive strength tolerated by the prepared sample after 28 days is better compared to the compressive strength measured after 7 days. The maximum compressive strength measured after 28 days is 34.88 N/m^2 for M3 cube. It indicates that when the percentage of mixing Coconut shells Ash (%), Groundnut shell Ash (%) and Fly Ash (%) is 1:2:1, then the sample provides maximum strength. The percentage increase in the compressive strength after adding the ashes compared to the normal concrete is 8.19 %.

B. Flexural Strength

It is used to measure the flexural strength of the prepared as per the code IS 516:1959 from figure, It is measured by applying load on the prepared beam of size 150mm×100mm ×100mm with a span length of at the minimum of three times the depth.The main disadvantage of this test is that it is very sensitive and difficult to handle. This is due to the heaviness of the beam. The beam might be damaged when taken from the field to the lab. To overcome this problem two samples of the beam has been prepared.

Table 3 Flexural Strength

Number of Samples	After 7 days (N/mm^2)	After 28 days (N/mm^2)
M0	4.65	5.68
M1	4.44	5.42
M2	4.79	5.85
M3	4.83	5.91
M4	4.59	5.61
M5	4.57	5.59
M6	4.39	5.36

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

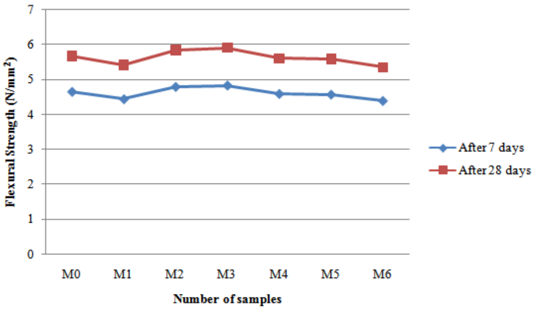

Figure 5: Flexural Strength

Flexural strength measured for the prepared beam after 7 days and 28 days respectively is shown in figure 5. The graph represents that as the duration of the prepared specimen increased the ability to bear stress also increased. The test performed after 28 days on the sample, it has been analyzed that the maximum flexural strength measured was about 5.91N/mm^2 for the 3rd sample. The percentage increase in the flexural strength after adding the ashes compared to the normal concrete is 4.05 %.

C. Rebound Hammer

The Rebound Hammer test is a non-destructive testing technique, which is used to represents the concrete compressive strength. Sometimes, this test is also known as the Schmidt hammer test, which utilized a spring -driven mass that slides over a spring-loaded plunger. The rebound hammer immerse is mounted against the concrete surface; constant energy with a controlled mass-spring is used to hit the specimen beam.The amount of surface hardness rebound is measured on a finishing scale. This measured value is designated as Rebound Number[21]. Low concrete and low hardness have more energy to give lower back-up value. The values measured during the rebound hammer testing are written in table 4.

Table 2: Rebound Hammer

Number of Samples	After 28 days (N/mm^2)
M0	38.69
M1	35.30
M2	41.08
M3	41.86
M4	37.76
M5	37.46
M6	34.51

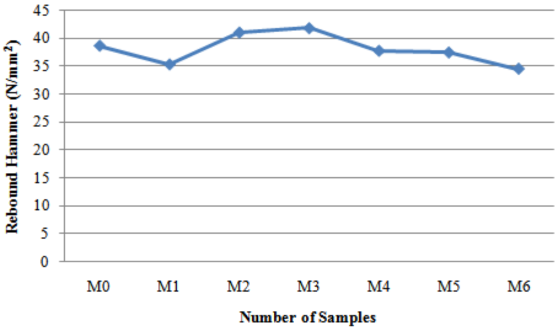

Figure 6: Rebound Hammer

Figure 6 represents the rebound hammer values measured for six different ratios of fly ash, coconut shell ash and ground nut shell ash. The testing has been analyzed after 7 days, and after 28 days respectively. The beam is prepared in the dimension of500 ×100×100 mm^3.The percentage increase in the rebound hammer after adding the ashes compared to the normal concrete is 14.09 %.

D. Ultrasonic Pulse Velocity Test

This test is used to measure the quality of concrete by passing the ultrasonic pulse through the prepared specimen. The time taken by the pulse has been measured. If the pulse reaches at the end of the surface in a shorter time, it indicates that the specimen has higher quality. If the time taken by the pulse is large it indicates that the specimen has multiple cracks. The values measured during the experiment are listed in table 4.

Table 4 Ultrasonic Pulse Velocity Test

Number of Samples	After 28 days (Km/sec)
M0	4.03
M1	3.68
M2	4.28
M3	4.36
M4	3.93
M5	3.90
M6	3.60

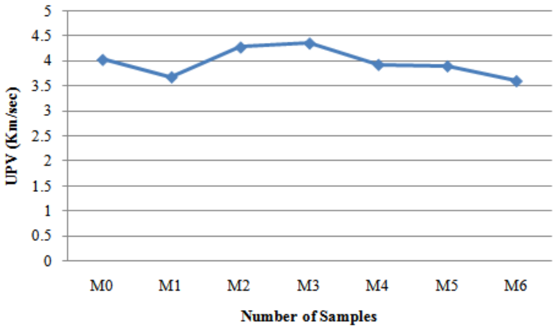

Figure 8:PVT

Figure 8 represents the graph obtained for UPVT values measured for six different specimens of size 150×150×150 which is prepared. The percentage increase in the PVT after adding the ashes compared to the normal concrete is about 8.19%.

V. Conclusion

Based on the above tests conducted on the prepared sample it has been concluded that sample M3 performs well in terms of compressive strength, flexural strength, rebound hammer and PVT. Following points are drawn:

The maximum compressive strength measured after 28 days is 34.88 N/ .

The maximum flexural strength measured was about 5.91 N/

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

The average of round hammer determined after 28 days is about 41.86 N/

The maximum UTVT value of 4.36 has been achieved.

It has been concluded that the compressive strength of presented work conforms to the characteristic strength of certain mixtures, since alternatives to these mixtures are reasonable for concrete production, and therefore the optimum mixture of concrete thus prepared must be considered to emphasize flexural strength. This work vividly shows that the total density of the concrete thus prepared is reduced. The authors suggest the use of coconut shells, fly ash with ground nut ash in concrete production not only because they make themselves as viable materials, but their utilization also helps to reduce the amount of environmental waste.

REFERENCES

1. Chindaprasirt, P., Jaturapitakkul, C., &Sinsiri, T. (2005). Effect of fly ash fineness on compressive strength and pore size of blended cement paste. Cement and Concrete Composites, 27(4), 425-428.
2. Festugato, L., & Corte, M. B. (2018). Discussion of "Unconfined Compressive Strength of Synthetic and Natural Mine Tailings Amended with Fly Ash and Cement" by Mohammad H. Gorakhki and Christopher A. Bareither. Journal of Geotechnical and Geoenvironmental Engineering, 144(5), 07018009.
3. Golewski, G. L. (2018). Green concrete composite incorporating fly ash with high strength and fracture toughness. Journal of cleaner production, 172, 218-226.
4. Ren, X., &Sancaktar, E. (2019). Use of fly ash as eco-friendly filler in synthetic rubber for tire applications. Journal of cleaner production, 206, 374-382.
5. Wang, Y. S., Dai, J. G., Wang, L., Tsang, D. C., & Poon, C. S. (2018). Influence of lead on stabilization/solidification by ordinary Portland cement and magnesium phosphate cement. Chemosphere, 190, 90-96.
6. Tam, V. W., Soomro, M., & Evangelista, A. C. J. (2018). A review of recycled aggregate in concrete applications (2000–2017). Construction and Building Materials, 172, 272-292.
7. Foti, D., &Cavallo, D. (2018). Mechanical behavior of concretes made with non-conventional organic origin calcareous aggregates. Construction and Building Materials, 179, 100-106.
8. Mousa, A., Mahgoub, M., & Hussein, M. (2018). Lightweight concrete in America: presence and challenges. Sustainable Production and Consumption, 15, 131-144.
9. Wu, H., Zhang, Y., Deng, Y., Huang, Z., Zhang, C., He, Y. B., ...& Yang, Q. H. (2019). A lightweight carbon nanofiber-based 3D structured matrix with high nitrogen-doping level for lithium metal anodes. Science China Materials, 62(1), 87-94.
10. Santos, S., da Silva, P. R., & de Brito, J. (2019). Self-compacting concrete with recycled aggregates-A literature review. Journal of Building Engineering.
11. Tufail, M., Shahzada, K., Gencturk, B., & Wei, J. (2017). Effect of elevated temperature on mechanical properties of limestone, quartzite and granite concrete. International Journal of Concrete Structures and Materials, 11(1), 17.
12. Nath, P., Sarker, P. K., &Biswas, W. K. (2018). Effect of fly ash on the service life, carbon footprint and embodied energy of high strength concrete in the marine environment. Energy and Buildings, 158, 1694-1702.
13. Nwofor, T. C., &Sule, S. (2012). Stability of groundnut shell ash (GSA)/ordinary Portland cement (OPC) concrete in Nigeria. Advances in applied science research, 3(4), 2283-2287.
14. Adebakin, I. H., Gunasekaran, K., &Annadurai, R. (2019). Mechanical properties of self-compacting coconut shell concrete blended with fly ash. Asian Journal of Civil Engineering, 20(1), 113-124.
15. Mandal, B., Tiwari, S., Ghimire, S., &Tiwari, A. (2018). Mechanical Properties of Concrete with partial replacement of Coarse aggregates by Coconut Shells and reinforced with Coconut Fibre. Journal of Building Materials and Structures, 5(2), 227-238.
16. Anifowose, M. A., Adeyemi, A. O., Oyeleke, M. O., Adebara, S. A., &Olatunji, A. A. (2018). Effect of Curing Age on Concrete Grade 20 Produced with Groundnut Shell Ash (GSA) Blended Calcium Chloride (CaCl2). Technology (ICONSEET), 3(12), 80-89.
17. Ikumapayi, C. M. (2018). Properties of groundnut shell (Arachishypogaea) ash blended portland cement. Journal of Applied Sciences and Environmental Management, 22(10), 1553-1556.
18. Hasholt, M. T., Christensen, K. U., &Pade, C. (2019). Frost resistance of concrete with high contents of fly ash-A study on how hollow fly ash particles distort the air void analysis. Cement and Concrete Research, 119, 102-112.
19. Ali, I. M., Naje, A. S., Al-Zubaidi, H. A. M., & Al-Kateeb, R. T. (2019). Performance evaluation of fly ash-based geopolymer concrete incorporating nano slag. GLOBAL NEST JOURNAL, 21(1), 70-75.
20. Saifullah, I., Rahman, M. M., Halim, A., & Islam, M. R. (2019). Mechanical and Bond Properties of Lightweight Concrete Incorporating Coconut Shell as Coarse Aggregate. American Journal of Civil Engineering and Architecture, 7(1), 38-46.
21. Nagarajan, V. K., Devi, S. A., Manohari, S. P., &Santha, M. M. (2014). Experimental study on partial replacement of cement with coconut shell ash in concrete. International Journal.

AUTHORS PROFILE

Er. Vijay Kumar: M.Tech in Structural Engineering (pursuing), University - Chandigarh University, Gharuan, Punjab, Publication Work – First Paper to be published

Er. Prince Sharma, Assistant Professor at Chandigarh University, M.Tech in Structural Engineering, Publication Work – 4 Research Paper Published