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Experimental Study Coconut Shell Ash and Glass Powder as Partial Replacement of Cement in Concrete

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ABSTRACT

Concerns over the sustainability of the environment and the planet's ecology have arisen due to the amount of waste produced by industrial and agricultural operations on the planet's surface. Waste generation contributes to global warming because it releases greenhouse gases into the atmosphere during disposal or manufacturing, including CO2. This investigation replaces the cement. By leftover materials including glass powder (GP) and coconut shell ash (CSA). Applying CSA and GP to cement substitutes of In the laboratory, over 108 specimens with concentrations of 0%, 2.5%, 5%, 7.5%, 10%, and 12.5% have been created and analyzed. Following being with a water/cement ratio of 0.55, the concrete is mixed in a weight ratio of 1:2.03:3.10 using cement sand and coarse aggregate. Investigated properties of concrete and cement include initial setting, final setting time, compressive strength, and flexural strength.

Keywords: CSA and GP, Initial setting, final setting time, Compressive strength, split tensile strength, and flexural strength

1. INTRODUCTION

Sand is used as the superior aggregate in concrete, which also contains water and admixtures. Due to global warming (GW) and environmental deterioration, the number of environmental challenges has increased recently. It may occur as a result of mass production, consumption, and waste creation. Glass doesn't normally hurt the environment since it doesn't generate pollutants, but when we fail to take care of it at that time, when it is hazardous and not biodegradable, it may quickly harm both humans and animals. Sand is used as the superior aggregate in concrete, which also contains water and admixtures. Due to global warming (GW) and environmental deterioration, the number of environmental challenges has increased recently. The characteristics of cement are improved by the alkali concentration. Additionally, it is employed in the production of ceramics and bricks. Glass powder is frequently used in a variety of civil engineering projects because it acts as an additional cementations cloth and coarse mixture. Usable and recyclable materials like glasses are also frequently used in these projects. Nearly all types of glass may be recycled. Additionally, it boosts concrete durability without affecting any of the material's properties. Glass and glass powder have lately been utilized in building to lessen environmental pollution. Glass powder does not experience the Alkali Silica Reaction (ASR) that occurs when coarse and fine glass aggregates are combined in concrete because it has additional cementations material (SCM). Glass powder is therefore used in place of SCM. (2016) Gautam and colleagues.

2. OBJECTIVE OF THE WORK

1. To study the improvement of the strength of conventional concrete using coconut shell ash and glass powder.
2. To find out the effect of the use of Glass Powder and Coconut shell ash as a partial replacement of cement to assess the pozzolanic nature of fine glass powder and coconut shell ash when mixed in concrete and
3. To know the changes occur in concrete properties as well as in various strengths

3. LITERATURE REVIEW

The study conducted by Ayyappa et al. (2020) aimed to conduct an experimental application to investigate the characteristics of concrete, particularly its workability and electricity. The researchers formed concrete cylinders with a peak height of 30 cm and a diameter of 15 cm using a concrete mixture of M20 grade, and concrete cubes of 150 mm x 150 mm x 150 mm. The experimental application is measuring the compressive energy of three cubes and the break up tensile strength of three regular concrete cylinders. Additionally, by adding various amounts of eggshell powder and coconut shell powder to the concrete mixture, comparison cubes and cylinders were made. The experiment considered substitute coconut shell probabilities of 2%, 4%, and 6%. The researchers also used eggshell powder in amounts of 5%, 10%, and 15% in place of cement as a technique to achieve the same level of energy as that obtained by adding coconut shells to the coarse mixture. The aim of the investigation was to determine how the addition of eggshell powder and coconut shells affected the strength and workability of the concrete. The researchers experimented with different concentrations of these additives in the concrete mixture to determine which ratios were crucial for delivering the requisite electrical and workability properties. Ordinarily, the examination provides useful information on enhancing the qualities of concrete and maybe reducing its environmental impact by partially replacing it with sustainable resources like coconut shells and eggshell powder. **The study conducted by Ibrahim (2021)** aimed to examine the acceptability and outcomes of replacing cement with waste glass powder (WGP) in three unusual forms of concrete: regular concrete, concrete with silica fume (SF), and urban concrete with fly ash (FA).The experiment tested various WGP ratios of 0%, 5%, 10%, 15%, and 20% of cement weight. Mechanical and other concrete features were examined at both the hardened and fresh ranges to determine the effect of WGP use. The test results showed that, in compared to the control blend without waste glass powder, using 5% WGP as a cement substitute increased the compressive and tensile strengths of conventional concrete (organization 1) by around 8% and 13%, respectively. Compared to the manipulate concretes, the compressive and tensile strengths of the silica fume and fly ash concrete (companies 2 and 3) were lower in all WGP replacement ratios. The electricity decreased through 13%–14% at a 20% WGP ratio. Similarly, basic, SF, and FA concrete mixes with 5%–20% WGP as a partial replacement of cement weight had lower water absorption and density than reference concretes (0% WGP).Comparing ordinary concrete (institution 1) to modify concrete at a 20% WGP ratio, ordinary concrete (institution 1) lost 3% of its fresh and dry density. The water absorption of specimens in firms 1, 2, and 3 made with 20% WGP also decreased by 27.78%, 14.75%, and 18.75%, respectively, as compared to the control concrete (zero% WGP).The study discovered that using waste glass powder as a partial replacement for cement in concrete changed into appropriate and improved workability for all types of concrete evaluated, with the exception of SF and FA concrete, where considerable power loss was stated at higher WGP alternative ratios. **The study conducted by Rath et al. (2022)** concentrated on the Chhattisgarh region of central India, a significant coal mining area with a big range of metal and electrical firms. Large-scale landfills and carbon dioxide emissions are caused by the enormous amounts of fly ash and pond ash produced by these power blooms. The significant carbon dioxide emissions inside the industrialized area lead to the corrosion of reinforced concrete systems. The researchers began by partially substituting locally available commercial wastes like fly ash and pond ash for cement and sand in order to examine the long-term performance of concrete. In order to test the workability, sturdiness, and strength of concrete, up to 40% fly ash by weight and up to 20% sand were substituted for cement in the mix. Additionally, all concrete combinations now contain continually 0.1% glass fiber by extent. The new coal ash fiber reinforced concrete mixtures were tested for rheology, shrinkage, electrical resistivity, ultrasonic pulse velocity, thermal conductivity, leaching check, compressive power, and flexural power, among other things. The results of these tests were used to propose a mixed design strategy for producing sustainable concrete with locally available commercial waste. The study aimed to provide a possible approach for managing company trash, as well as lowering carbon dioxide emissions and strengthening and extending the lifespan of concrete in the area. The goal of the project was to increase the use of sustainable concrete in construction and improve environmental safety by utilizing local business waste.

4. MATERIALS

Following are the basic tests performed on the constituent materials used, before casting concrete.

A. Cement

1. 33 grade OPC (follows IS 269)
2. 43 grade OPC (follows IS 8112)
3. 53 grade OPC (follows IS 12269)

The numbers 33, 43 and 53 represent the 28 days compressive strength of a standard cement sand mortar. This cement is very commonly used in normal concrete constructions.

a. Fineness of cement
b. Specific gravity of cement

B. Fine aggregate

a. Sieve analysis of fine aggregate
b. Specific gravity
c. Water absorption

The size of the sand must be between 75microns to 4.75mm. That means it must completely pass through IS 4.75mm sieve and completely retained on IS 75 micron sieve

C. Coarse aggregate

a. Sieve analysis of coarse aggregate
b. Specific gravity
c. Water absorption

It is generally comprises of crushed stones like granite. Sometimes gravel or broken bricks are also used as coarse aggregates. Coarse aggregate occupy the most part of the concrete matrix and contribute toward weight and strength of the hardened concrete

A. Cement

Cement is also easily available in market .It is used as binder material. It is widely used to bind sand and gravels altogether with it. It sets and gets harden with time when mixed with water. Ordinary Portland cement (OPC) has been used in the present work. It is a type of blended cement which is obtained by clinkers, gypsum materials and thoroughly mixing them in correct proportions. Portland is a natural material containing siliceous or siliceous-aluminous substance in the reactive form which, when combines with calcium hydroxide in the presence of water produces calcium silicate and aluminate hydrate compounds having cementations properties. The testing of concrete is done according to IS Code 10262 Portland cement of 43 grades conforming to IS 8112-1989 was used. And specific gravity 3.15 was used.

Figure: 1 Ordinary Portland cement

B. Fine Aggregates (sand)

By definition, fine aggregates pass through IS sieve size 4.75 mm. Selecting fine aggregate on the basis of its zone of gradation, surface texture, water absorption, particles shape and size gives concrete better durability, strength and makes it economic. Specifications of aggregate used fulfils the requirement as per IS: 383-9170. Other properties of fine aggregate like specific gravity, water absorption, etc. satisfies IS: 2386 (part III). Calculated specific gravity and water absorption for fine aggregate was found to be 2.65 and 0.84% respectively

Figure 2: Sand Sample

C. Coarse Aggregate

By definition, coarse aggregates get retained on IS sieve size 4.75 mm. Construction aggregates which makes bulk of the concrete adds strength to the overall composite materials. Aggregates used in the testing and casting should be free from dust particles, mud or any other impurities. In this thesis work, machine crushed basalt stones of maximum 20 mm size are used. Specifications of aggregate used fulfils the requirement as per IS: 383-1970. Some tests were performed to determine the properties of coarse aggregate as per IS: 2386 (part III). Calculated specific gravity of coarse aggregate used in the experiment was found to be 3.125. Testing for the water absorption of coarse aggregate was performed and the calculated result was 2.0%.

Figure: 3. Course Aggregate Sample

D. Water

Water is easily available and inexpensive but the most important ingredient of concrete. The water must be free from impurities like oil, alkali, acid etc which is used for mixing concrete. Water is essential material of concrete which gets combined with cement to form a cement paste by the process of hydration. Then this cement paste adheres to aggregates and fills the voids to get better strength and bond among constituent materials. Water used was natural potable which satisfies the provisions of IS 456:2000.

E. Waste Glass (Glass Powder)

Due to its distinctive qualities, glass is a material that may be employed in a wide range of applications. It is a translucent, amorphous material that is frequently used for windows, doors, and car windows. And bottles, among other things. Glass also finds applications in scientific fields and industries due to its physical and optical properties.

Figure: 4 Sample of glass powder

F. Coconut Shell Ash (Powder)

The use of coconut shell ash in concrete production offers several benefits, particularly in terms of cost reduction and environmental sustainability. As you mentioned, the rising cost of various concrete components is a major worry for the building sector. Concrete manufacturing costs can be decreased by using coconut shell ash as an additive or as a partial replacement for cement, making it a cost-effective solution.

Figure 5 Sample of coconut coconut ash

5. RESULTS

A. COMPRESSIVE STRENGTH OF CSA AND GP MIXED CONCRETE

At the ages of 7, 14, and 28 days, the compressive strength of all the created mixes was assessed for the various CSA and GP addition levels to cement concrete. The several tables below provide the average compressive strength values for various mixes made by adding CSA and GP (0%, 2.5%, 5%, 7.5%, 10%, and 12.5%) at the end of various curing times (7 days, 14 days, and 28 days).

Figure 6 Cured cast cube specimens and casted cube specimens

Figure 7 Compressive strength testing using CTM

Table 1. Glass Powder (GP) Combine Compressive Strength all mixes of concrete

S. No.	GP %	Strength of Compression After Seven Days (N/mm2)	Strength of Compression After 28 Days (N/mm2)
1	0%	13.47	25.10
2	2.5%	15.05	26.39
3	5%	16.96	27.16
4	7.5%	18.06	27.90
5	10%	19.48	29.02
6	12.5%	18.21	27.18

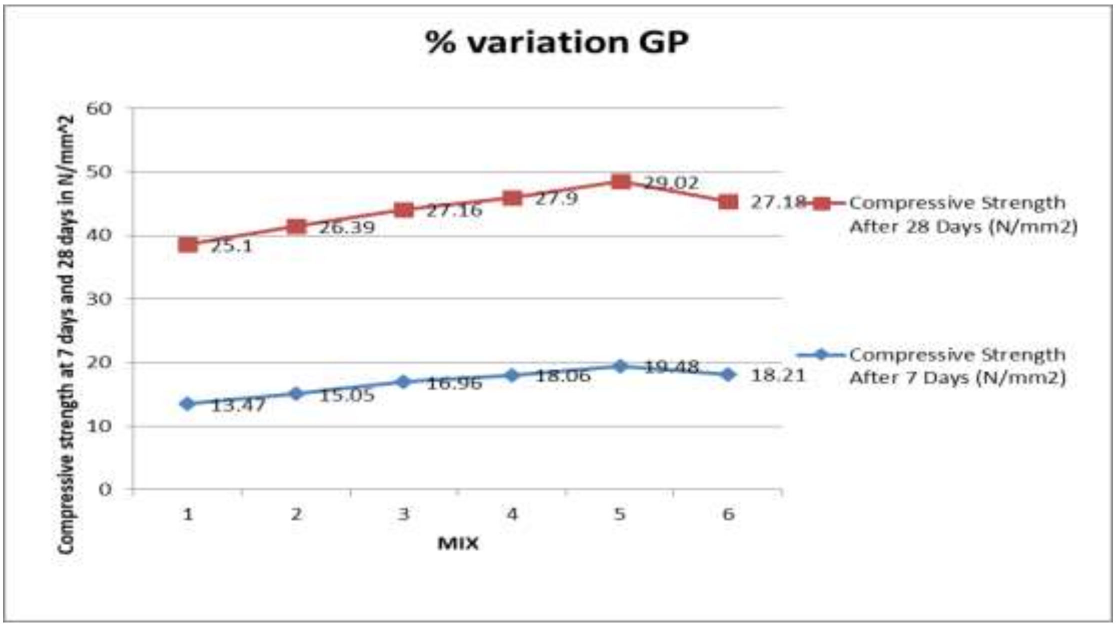

Figure 7 Combine Compressive strength at 7 day and 28 days for all mixes of Glass Powder

Table 2 Combine Compressive Strength of Coconut Shell Ash (CSA) Mix Concrete for all Mixes

S. No.	CSA %	Compressive Strength After 7 Days (N/mm^2)	Compressive Strength After 28 Days (N/mm^2)
1	0%	14.48	2.538
2	2.5%	15.71	2.583
3	5%	17.16	27.17
4	7.5%	18.32	27.97
5	10%	19.44	28.44
6	12.5%	18.26	26.98

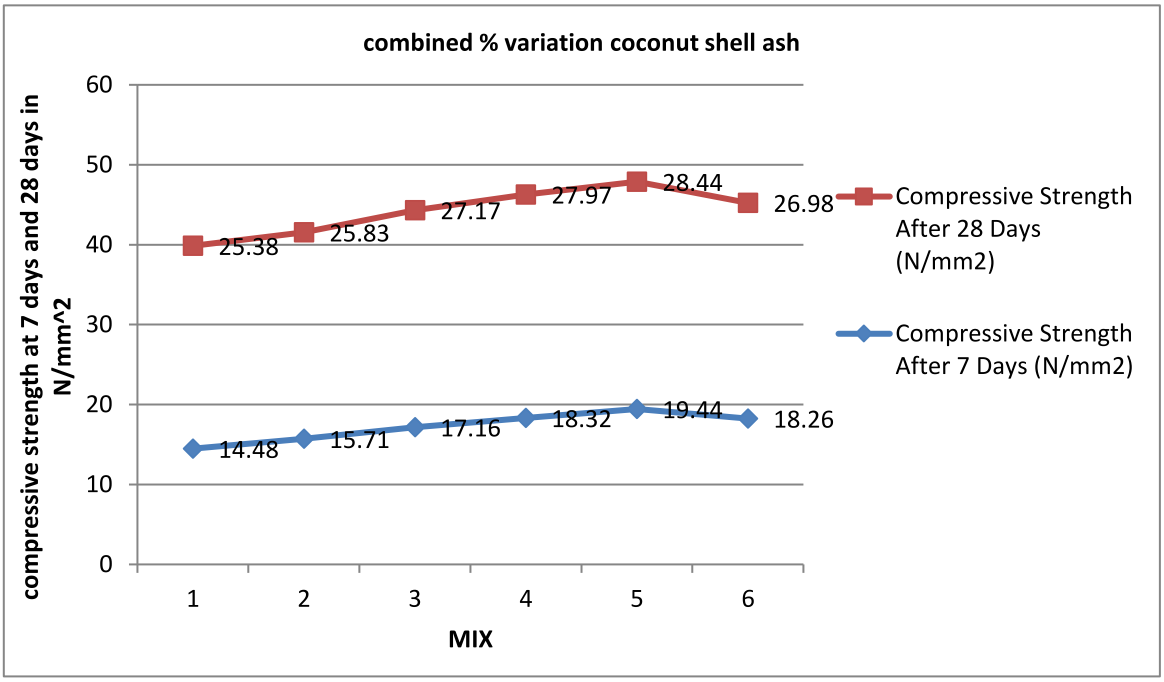

Figure 8 Combine Compressive strength at 7 day and 28 days for all mixes of Coconut Shell Ash

B. FLEXURAL STRENGTH OF CSA AND GP MIXED CONCRETE (IS: 516-1959)

The flexural strength test of beam, a specimen of size (700*150*150) mm is placed over two- point loading arrangement and the stress produced during breakage of specimen. The flexural strength is reported as Modulus of Rupture (N/mm) and calculated as

Flexural strength Ft =1.5 pl/bd^2

Where

P=Load at which the beam specimen fails (in KN) L=Effective length of the bam specimen (in mm)

b, d = Width and depth of the beam specimen (in mm)

Table 3 Combine Flexural Strength of Coconut Shell Ash (CSA) Mix Concrete for all Mixes

S. No.	CSA %	Flexural Strength After 7 Days (N/mm^2)	Flexural Strength After 28 Days (N/mm^2)
1	0%	5.77	7.45
2	2.5%	6.13	7.82
3	5%	6.40	8.12
4	7.5%	7.23	9.20
5	10%	6.61	8.52
6	12.5%	6.55	8.39

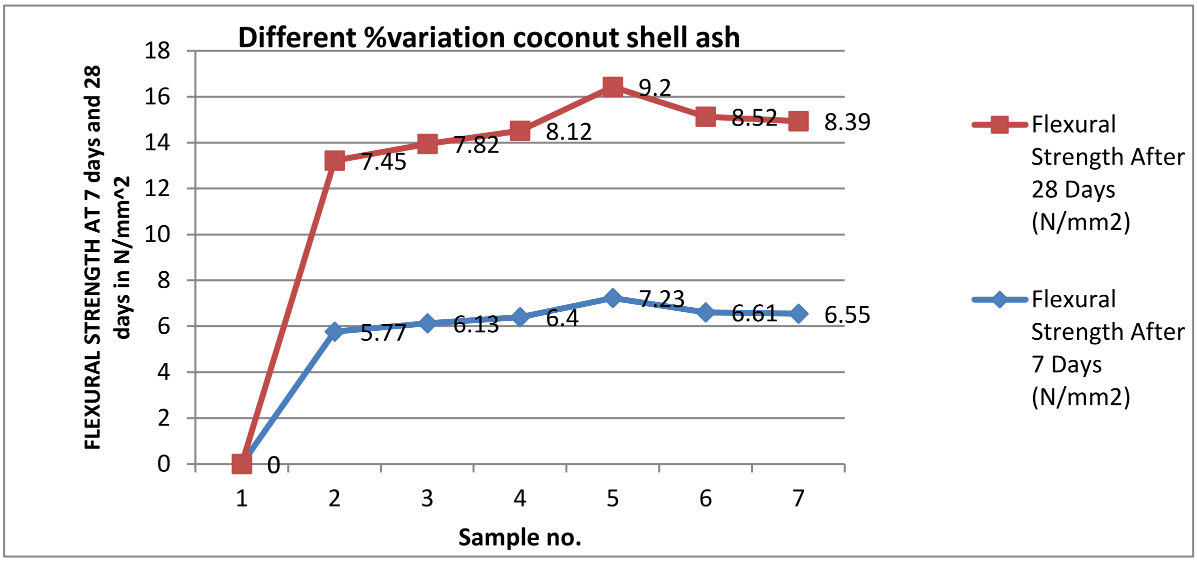

Figure 9 Combined Flexural strength at 7 day and 28 days for all mixes of coconut shell Ash

Table 4. Combine Flexural Strength of Glass Powder (GP) Mix Concrete for all Mixes

S. No.	GP %	Flexural Strength After 7 Days (N/mm^2)	Flexural Strength After 28 Days (N/mm^2)
1	0%	5.08	6.35
2	2.5%	5.85	7.69
3	5%	6.33	8.03
4	7.5%	7.18	9.22
5	10%	6.48	8.41
6	12.5%	651	8.31

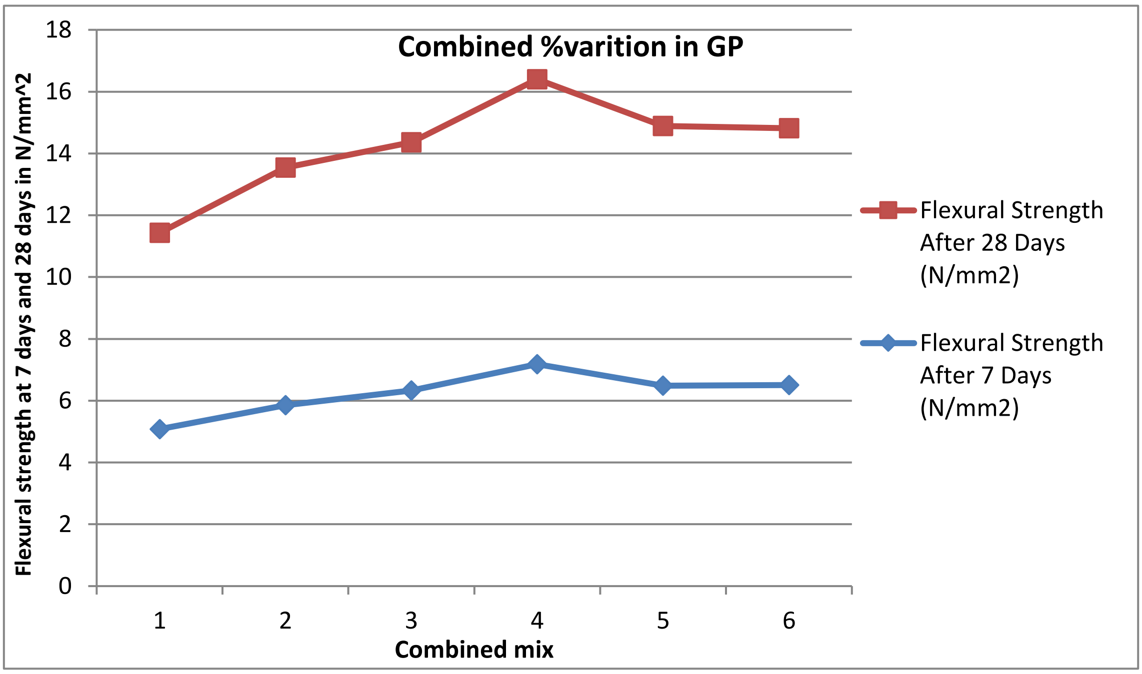

Figure 10 Combine Flexural strength at 7 day and 28 days for all mixes of Glass Powder

10. CONCLUSION

1. Concrete can benefit from the addition of waste coconut shell ash (CSA) and glass powder (GP), which increase the material's compressive strength and flexural strength.
2. The density of the concrete mix is only slightly affected by the inclusion of waste CSA and GP.
3. Up until a certain extent, the addition of waste CSA and GP strengthens concrete. The strength abruptly decreases after crossing this point because the concrete is less able to properly join together.
4. At 7 days and 28 days of curing with a 7.5% addition of CSA and GP, the concrete's compressive strength and flexural strength gradually improve. Beyond this, the strength qualities gradually deteriorate as the CSA and GP addition rises.
5. The mixture with a water-to-cement ratio of 0.55 and 10% CSA and GP added has the highest compressive strength. Consequently, this specific mixture is advised for gaining the most strength.
6. Overall, the research results highlight the benefit of including glass powder and waste coconut shell ash in concrete mixtures. These waste products serve as pozzolanic additives that improve the strength of the concrete without barely changing its density. The study offers insightful information for the proper and effective exploitation of these waste materials in concrete construction, encouraging environmentally friendly practices in the building sector

REFERENCES

1. Gunalaan Vasudevan, Seri Ganis Kanapathy pillay (2013) Performance of Using Waste Glass Powder In Concrete As Replacement Of Cement American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-12, pp-175-181 www.ajer.org
2. Harish B A, Hanumesh B M, Siddesh T M, Siddhalingesh B K (2016) An Experimental Investigation on Partial Replacement of Cement by Glass Powder in Concrete International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 10 | Oct-2016 p-ISSN: 2395-0072
3. Jagriti Gupta, A.S. Jethoo, P.V. Ramana (2022) Evaluating long term properties of concrete using waste beverage glass material today proceedings Volume 61, Part 2, 2022, Pages 297-306 https://doi.org/10.1016/j.matpr.2021.09.446
4. K. I. M. Ibrahim "Recycled waste glass powder as a partial replacement of cement in concrete containing Silica Fume and Fly Ash" Case studies in construction material (CSCM), vol. 15, pp. 1-10, 2021.
5. M. Arivazhagan, T. Balakrishna, A. Deepak, M. Hariskumar (2019) "Experimental study on partial replacement of cement by groundnut shell ash in concrete" International Journal of Current Engineering and Scientific Research (IJCESR), vol. 6, no. 3, pp. 144-160, 2019.
6. M. J. Garba, A.S.J. Smith, E. N. Ogork, A. Aboshio "Effect of coconut shell ash (CSA) an admixture on the properties of cement paste and concrete "British Journal of Educational Technology (BJET), vol. 15, no. 02, pp. 22-29, 2020.
7. Tajamul Margey, Bital Malik, Mohd Akeeb Rar, Nazeer Bijian "Coconut Shell and waste glass-based concrete -A comparative study" International Journal of Engineering Development and Research (IJEDR), vol. 04, no.01, pp. 359-371, 2016.
8. V. Sravika, G. Kalyan "A Study on the partial replacement of course and fine aggregate by coconut shell quarry dust mix" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), vol. 14, no. 4, pp. 63-69, 2017.
9. Veena V. Bhat, N. Bhavanishankar Rao (2014) Influence of Glass Powder on the Properties Of Concrete International Journal of Engineering Trends and Technology (IJETT) – Volume 16 Number 5 – Oct 2014 ISSN: 2231-5381 http://www.ijettjournal.org.
10. Vignesh Kumar Nagarjun, S. Aruna Devi, S. P. Manohari, M. Maria Santha "Experimental study on partial replacement of cement with coconut shell ash in concrete" International Journal of Science and Research (IJSR), vol. 3, no. 3, pp. 651- 661, 2014.