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Comparative Study of Conventional Concrete and Green Concrete Made Of Fly Ash, Recycled Red Bricks and Recycled Crushed Aggregates

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Abstract: Because cement is a binding substance, it is commonly utilized in building. Cement production accounts for 8-10% of total world CO2 emissions.. This greenhouse gas is produced when lime stone and clay are smashed and heated to high temps in mills. Concrete contributes significantly to greenhouse gas emissions and complicates waste disposal. Therefore the use of recycled materials in concrete has become necessary. A Danish scientist by the name of Dr. WG made the initial discovery of green concrete in 1998, which has been a groundbreaking idea in the history of concrete. The term "green concrete" refers to a type of concrete that includes recycled components that are environmentally friendly, has greater performance, and have a longer life cycle .By utilizing industrial ecology, green chemistry, as well as the structural behaviour and organisation of cement nano-particles in the mix for higher performance, researchers have made numerous attempts to find alternatives that can significantly reduce high energy consumption and environmental impacts during the fabrication process of cement.

It is also Observed that the increase in RHA to 20% i.e (Mix 2) & not changing the other two components, leads to the decrease in the strength, this is because of much replacement of Materials which effects the binding Factor of Cement & Aggregates. The Main Advantage of RHA replacement by 10% shows high strength growth by 33% when compared to conventional Concrete on 28th Day.

In this assignment, we'll conduct tests on both freshly laid concrete and hardened concrete, including a compressive strength test. In this project, the typical components of concrete, such as F.A. and C.A., are substituted by powdered clay brick and crushed glass waste, respectively. Cement is also partially replaced with rice husk ash. M20 is the concrete grade that was employed.

Keywords: Green Concrete, Rice Husk Ash, Clay from demolished Bricks, CO_2 emissions, Crushed glass waste.

I. INTRODUCTION

The Latin word "concretes" is where the term "concrete" originates (meaning compact or condensed). Gravel, cement, and water are the main components of the composite construction material known as concrete. The most widely used man-made material in the world, concrete is available in a variety of compositions with different properties. While concrete contributes considerably to emissions of carbon dioxide and makes disposal of remaining concrete from demolished sites more difficult, the ecological production of cement is a mixed bag of not entirely negative effects. As a response, concrete recycling is now required. One of the most important environmental dangers today is the greenhouse effect. Concrete manufacturing contributes significantly to global warming, accounting approximately 30% of total CO2 emissions into the atmosphere. Civil engineers have developed a new concrete idea called as "GREEN CONCRETE" as a result of the aforementioned causes.

In the history of the concrete industry, green concrete is a novel idea, having been established in Denmark in 1998. Green Concrete is a form of concrete identical to ordinary concrete, except its manufacture consumes less energy and has a lower environmental effect. It is the use of ecologically friendly components in concrete to increase the overall sustainability of the system. Green Concrete is regularly and cheaply made; for example, waste products are utilised as cement and, to a lesser extent, fine aggregate replacement materials. The worldwide building business is rapidly developing. Building Materials are in high demand as a result of massive construction. Aggregates are the primary components of concrete. Because of continual mining, the availability of aggregates has lately become an issue. To solve this issue, there is a need to find a substitute, which may be found in the form of green materials. As an alternative to cement, raw materials for green concrete may be sourced from destroyed sites and industrial waste, such as fly ash, rice husk ash (RHA), and silica fume, and powdered brick clay as a partial substitute for fine aggregate. These green materials have mechanical and fire resistance qualities that are almost equal to regular concrete. It offers outstanding thermodynamic, environmental, and durability characteristics. It is also less expensive and faster to build.

The word "green" refers to more than simply the colour green; it also describes our current climate. Slag, recycled concrete, demolition and building debris, used glass, and municipal solid waste fly are all examples of garbage. Ash, red mud, burned clay, combustion ash, and foundry sand are other alternatives to cement and fine aggregate. Concrete that has gone above and above in terms of mix composition and installation to provide a long-lasting structure life cycle with minimal maintenance is known as "green concrete."Examples include energy savings, CO2 emissions, and trash reduction.Green Concrete meets the following major properties of conventional concrete:

1) Mechanical properties like as strength, shrinkage, creep, and static behaviour; fire resistance (heat transfer); and workability (strength development, curing etc.).
2) Reliability (corrosion protection, frost, new deterioration mechanisms etc.).
3) Environment-related factors (CO2-emission, energy, recycling).
4) This is due to the presence of pozzolanic alternative, specifically rice husk ash, which is used to partially replace cement (RHA).

The following are a few advantages of using green concrete: NO environmental contamination, sustainable development, and a 10–20% reduction in the CO_2 emissions of the concrete sector.

a) Superior heat and fire resistance compared to standard concrete; better compressive strength behaviour when compared to standard concrete.
b) Due to the use of waste resources like ceramic waste and aggregates, the consumption of waste goods in the concrete industry increased by 20%. Therefore, green concrete is more cost-effective and uses less energy.
c) As a result, utilising green concrete and other concrete products in the future would not only minimise CO2 emissions and environmental impact, but also be practical from an economic standpoint.
d) Green concrete requires less upkeep and repair.
e) Green concrete is simpler to work with than traditional concrete.

II. LITERATURE REVIEW

1) In 2016, Anita Bhatia, et al

Submits a dissertation on green concrete, stating that green concrete consumes very little energy and resources, emits no pollution, and supports long-term growth.

One can argue that addressing the aforementioned limitations will facilitate the usage of green cement concrete in a potentially more ecologically friendly future.

We may help to alleviate environmental problems and safeguard naturally available materials for future generations by using garbage as an alternative.

2) In 2016, Praveer Singh, et al

Because of the growth in demand, cement is turning into a rare resource all around the world, according to research on silica fume. In recent years, the use of silica fume as a pozzolanic ingredient has grown since it enhances the properties of both fresh and hard concrete when mixed in appropriate proportions. The addition of silica fume in the proper quantity increases concrete durability and conditions.

3) In 2016, Tae Hyoung Kim, et al

Performed study on CO2 emissions from concrete and concluded that concrete, a common building material, is known to create a considerable part of economically hazardous waste throughout the manufacturing, construction, maintenance, and demolition processes. Concrete manufacturing's CO2 emissions contribute to acidification and the greenhouse impact.

4) In 2015, Kasi Rekha, et al

The use of aggregate concrete to produce low yield regenerated aggregate suitable for concrete production was discovered as a result of study on brick wastes.

The findings showed that recycled brick aggregate concrete outperformed granite aggregate concrete at high temperatures. Concrete made with recycled brick aggregate outperforms concrete made with granite in terms of fire resistance.

5) In 2015, Dhiraj Kumar Tiwari, et al

A study on green concrete found that the use of solid wastewater to help the environment of fossil fuels as well as environmental pollutants defines green concrete as being capable of sustainable development. Green concrete is a practical method for lowering pollution levels and improving the resilience of concrete in challenging conditions. Heat and fire are not able to burn through green concrete.

6) In 2014, Chirag Garg, et al

Publishes a journal article on the topic of green concrete, and they reach the conclusion that it is created from recycled concrete ruins. The method for selecting a medium for green concrete is explained in the article. It has been discovered that 0.9 tonnes of CO2 are produced for every tonne of cement produced. Furthermore, 10% by weight of cement is used in eco-friendly construction methods. As a result, using green concrete can encourage environmentally beneficial building practises while also helping to lower CO2 emissions in the atmosphere. The use of manufactured and recycled aggregates in construction is increasingly supported through incentives.

7) In 2014, Umesh Sharma, et al

Due to inherent strength properties, concrete is the most significant engineering material in the building sector, according to research on silica fume. Micro silica is composed mostly of extremely fine smooth spherical silicon nano-particles with a very high surface area. Micro silica particles are one hundred times smaller than cement particles. Silica fume is typically classified as an auxiliary cementitious ingredient. These materials have pozzolanic qualities, cementitious properties, or a combination of the two, which can impact the concrete's behaviour in a variety of ways. Silica fume is indeed a substance that may contribute to air pollution. Some industries produce this as a by-product. The use of micro-silica in concrete reduces air pollution. Silica fume also reduces cavities in concrete.

8) In 2012, Verma Ajay, et al

In their study, they determined that concrete is the most essential engineering material and that the inclusion of additional components may affect the properties of concrete. There is an increasing demand for aggregate with a stronger compressive strength as the trend toward wider usage of concrete for high-rise buildings grows. Materials are classified into two types: crystalline and non-crystalline. Micro silica, often known as silica fume, is a very fine non-crystalline substance. As a by-product of the manufacturing of elemental silicones or alloys containing silicon, silica fume is created in an electric arc furnace. Silica fume was previously regarded as a cement replacement material, and in some areas it is still utilised as such. However, far smaller quantities of silica fume may be employed as pozzolanic admixtures. Silica fume boosts concrete strength by 25%. Because silica fume is far cheaper than cement, it is particularly essential from an economic standpoint.

III. MATERIALS AND PROPERTIES

A. Cement

Portland cement is hydraulic binder made by finally pulverizing the clinker developed by oxidizing to incipient fusion a blending of argillaceous and calcareous equipment. Bilge is an illusionary rock manufactured by vaporising lime stone and other commodities in separate batches to a very high temperature in a specifically adapted kiln. The most significant ingredient in concrete is fine grind powder, hence the term cement concrete. Portland cement is a generic word for hydraulic cement. Cement is often made from lime stone ($CaCo_3$), sand (SiO_2), stale clay (SiO_2, AI_2O_3, or Fw_2O_3), and iron ore (Fe_2O_3). Cement's chemical components include calcium (CA), silicon (Si), aluminium (Al), and iron (Fe).

B. Aggregates (Fine and coarse aggregates)

Aggregates are the main components of concrete. They account for 70-75% of the entire volume, serve as a solid crystalline structure for limestone, and serve as cost-effective space fillers. IS383 specifies the aggregate requirements. They are nontoxic and are classified into two types based on their size: fine and coarse. They add to the strength and durability of concrete. In most cases, coarse aggregate is generated from rock. Their qualities are determined by the mineralogy of the rock, the ecological contact under which the rock has been treated, and the process of crushing used to obtain different sizes. Crushed rock is utilised as coarse aggregate in India, whereas river sand is used for fine aggregate.

Recently, the scarcity of river sand has necessitated the development of artificial sands, particularly in southern states. The physical, chemical, and thermal qualities of aggregates have a significant effect on the results of concrete.

C. Classification of Aggregates

Crushed rock is utilised as coarse aggregate in India, whereas river sand is used for fine aggregate. Recently, the scarcity of stone dust has necessitated the development of artificial sands, particularly in southern states. The physical, chemical, and thermal qualities of aggregates have a significant effect on the results of concrete.

D. Rice Husk Ash

In place of cement, rice husk ash is used to make concrete. The many forms, traits, advantages, and applications of rice husk in manufacturing are explored. A by-product of the milling of rice is rice husk. The growing problem of environmental contamination as well as the concern for sustainability led to the utilization of rice husk. The reasons rice husk is used in place of cement while making concrete are discussed in the sections that follow. To get a good idea of how rice husk performs in concrete, a thorough examination of its features is required.

Around 100 billion tonnes of rice paddy production by-products are produced annually worldwide. They have a bulk density of 90 to 150 kg/m3. The dry volume value consequently rises. The surface of the rice husk is extremely abrasive and rough. They are hence resistant to natural degradation. This would lead to issues with incorrect disposal.

Finding a way to use these by-products to create a new product is the best long-term answer. Of all the industries that can reuse rice husk, cement and concrete manufacturing can use it most effectively.

Fig 1: Rice husk ash

E. Demolished Red Bricks

The first considerable use of crushed brick as aggregates in fresh concrete was reported for reconstruction following World War II, but the earliest use of clay with Portland cement for the production of concrete products was documented in Germany (1860). The main advantages of using recycled brick granules as replacement granules are minimising bulk durability, lowering the usage of natural aggregate, and being seen as an ecologically beneficial method. Poon and Chan investigated the utilisation of crushed clay brick as sub-base equipment aggregate. The use of crushed clay brick aggregate as a complete substitute for coarse natural material in concrete was studied by Akhtaruzzaman and Hasnat. The formability of cement brick formed from crushed clay bricks were discussed by Sadek.

Clay brick debris was crushed using a specialised procedure to produce recycled aggregates and powder. Using a steel hammer, clay bricks were hand smashed before being screened through a 4.75mm mesh.

Fig 2: Demolished Red Bricks

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F. Crushed Glass

The rising awareness of glass recycling has accelerated the examination of the use of discarded glass in a variety of disciplines. One of its most notable contributions was to the building industry, where waste glass was utilised to produce concrete. Glass still has to be used more effectively in marble used in architecture. Crushed and screened waste glass is a robust, secure, and economical substitute for sand in concrete, according to several research. Over the past few decades, it has been determined that the garbage generated by manufacturing, building sites, and retail outlets is growing significantly. The use of recycled glass in the concrete building industry is advantageous since it lowers the cost of concrete making. Because of the increased usage of glass items, the amount of wasted glass has grown dramatically in recent years.

The vast majority of waste glasses have ended up in landfills. Because wasted glasses are not reusable, they are less ecologically friendly when disposed of. The utilization of waste glass in concrete construction has tremendous potential. The production cost of concrete is lowered when waste spectacles are reused in the construction of concrete items. When properly sized and handled, shattered glass or cullet can have qualities comparable to gravel or sand. Waste must be recycled in order to provide efficient design for use in building construction.

Fig 3: Crushed Glass

IV. METHODOLOGY

Global warming is one of the most serious environmental challenges today. Concrete production is a critical factor in global warming because it accounts for 30% of total CO2 emissions into the atmosphere. As a result of all of these considerations, Green Concrete has come to the fore. In our study, rice husk ash (RHA) is substituted to cement by 10% and 20%, respectively, while powdered clay from dismantled bricks is replaced to sand by 20% and 5% of recycled aggregate is added with reference to coarse aggregate, which was left alone. On cemented concrete, the compressive strength was measured for 28 days. When cement replacement, the outcomes were positive and useful.

Here we will discuss a study on concrete that uses (RHA) as a substitute of cement, powdered clay from demolished bricks as a mix proportion for Fine Aggregate, and crushed glass with Coarse Aggregate that is mixed using the mix proportion M20 as per Indian standards in order to execute various tests on concrete such as fresh concrete tests and hardened concrete tests and correlate these tests to conventional concrete.

V. RESULT AND DISCUSSION

A. Results Of Cement Sample

Table I Results of Cement Sample

S.NO	Characteristics	Values obtained
1.	Consistency	31%
2.	Initial setting time	45min
3.	Final setting time	500min
4.	fineness	6%
5.	Specific gravity	3.09

B. Tests Results Of Fine Aggregate

Table 2 Results of Fine Aggregate

S.NO	TEST	RESULTS
1.	Zone	II
2.	Specific gravity	2.6
3.	Fineness modulus	3.75
4.	Water absorption	0.6%

C. Tests Results of Coarse Aggregate

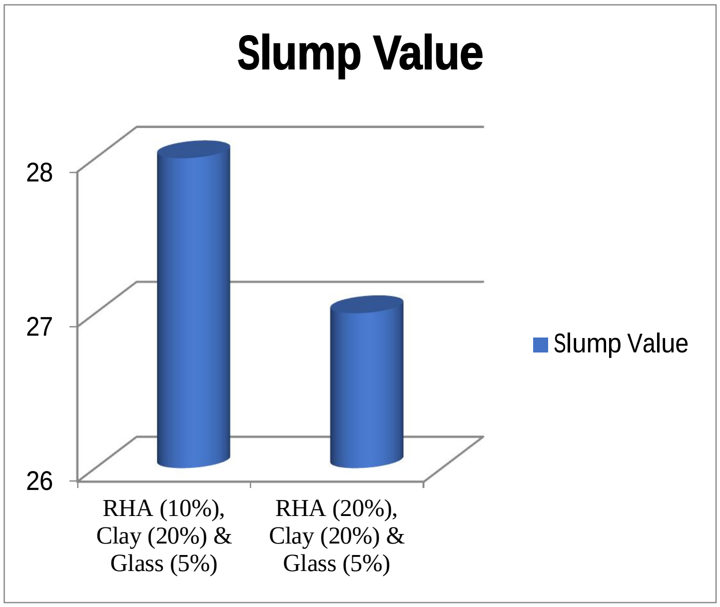
Table 3 Results of Coarse Aggregate

S.NO	Test	Result
1.	Specific gravity	2.66
2.	Fineness modulus	6.23
3.	Water absorption	0.3%

D. Slump Cone Test on Fresh Concrete:

Table 4 Slump Value of Fresh Green Concrete

S. no	Percentage replacement of Eco-Friendly Materials with Components of Conventional Concrete.	Slump Value
1	RHA (10%) for Cement Powdered Clay (20%) for Fine Aggregate Addition of 5% glass with C.A	28mm
2	RHA (20%) for Cement Powdered Clay (20%) for Fine Aggregate Addition of 5% glass with C.A	27mm



Graph 1: Comparison of Slumps

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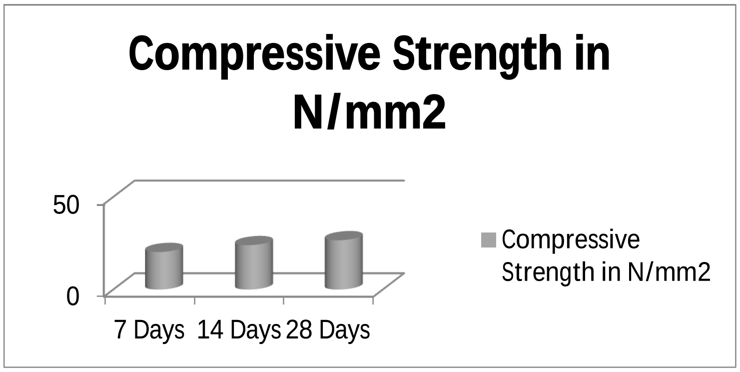
E. Compressive Strength Of Green Concrete With RHA (10%) For Cement, Clay For Sand(20%) & Glass With C.A (5%) :

Table 5: Compressive strengths of Green Concrete Obtained

S. no	Percentage replacement of Eco-Friendly Materials with components of Conventional Concrete.	Age in Days	Load Applied in (KN)	Compressive Strength (N/mm^2)	Average compressive strength (N/mm^2)
1	1) RHA (10%) in replacement for Cement + 2) Powdered Clay (20%) in replacement for Sand / F.A + 3) 5% Glass added with C.A	7 Days	450	20.00	20.29
			470	20.88	
			450	20.00	
		14 Days	540	24.00	23.99
			530	23.55	
			550	24.44	
		28 Days	600	26.66	26.63
			610	27.1	
			590	26.2	



Graph 2:Representing Compressive Strengths of Green Concrete

F. Compressive Strength Of Green Concrete With Rha (20%), Clay For Sand(20%) & Glass With C.A (5%)

Table 6: Showing Compressive Strength Of Green Concrete

S. no	Percentage replacement of Eco-Friendly Materials with components of Conventional Concrete.	Age in Days	Load Applied in (KN)	Compressive Strength (N/mm^2)	Average compressive strength (N/mm^2)
1	1) RHA (20%) in replacement for Cement + 2) Powdered Clay (20%) in replacement for Sand / F.A + 3) 5% Glass added with C.A	7 Days	220	9.77	10.36
			230	10.22	
			250	11.11	
		14 Days	340	15.11	14.96
			320	14.22	
			350	15.55	
		28 Days	430	19.11	19.25
			430	19.11	
			440	19.55	

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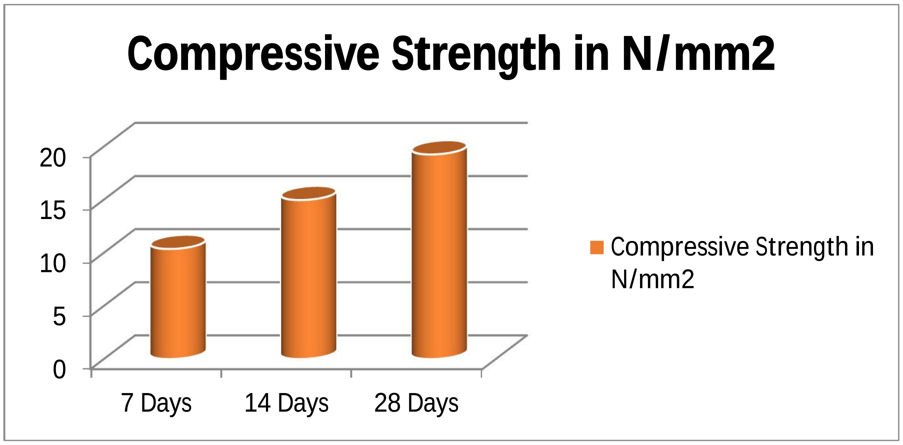
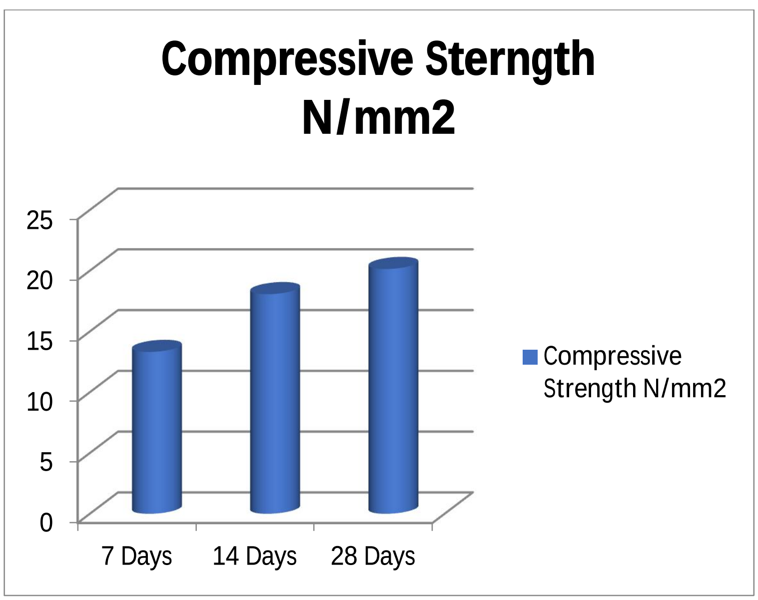


Graph 3:Representing the Compressive Strength of Green concrete

G. Compressive Strength Of Conventional Concrete:

Table 7: Showing Compressive Strength Of Conventional Concrete

S. no	Particulars	Age in Days	Load Applied in (KN)	Compressive Strength in (N/mm2)	Avg Compressive Strength (N/mm2)
1	Cement + F.A + C.A	7 days	290	12.88	13.32
			310	13.77	
			300	13.33	
		14 Days	410	18.22	18.07
			410	18.22	
			400	17.77	
		28 Days	450	20	20.14
			460	20.44	
			450	20	



Graph 4: Representing the Compressive Strength of Conventional concrete

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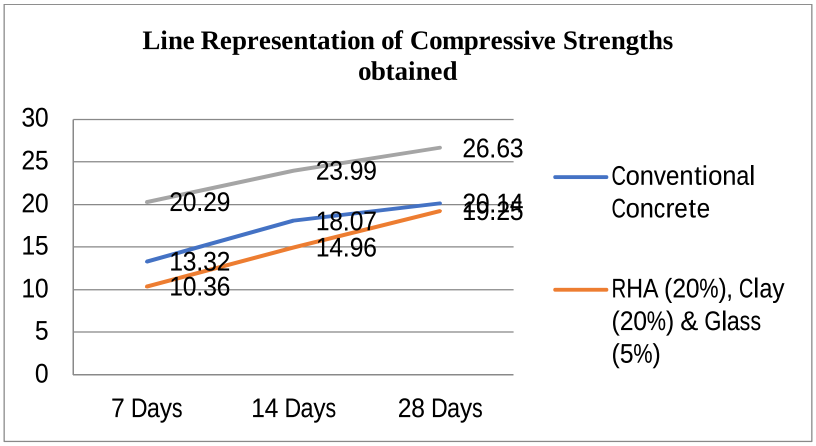
H. Graph Comparision Of Conventional Concrete & Green Concrete With Varied Replacement Percentages:



Graph 5: Line representation of compressive Strengths

VI. CONCLUSIONS

There by we can conclude that the strength of Samples with Mix 1 i.e RHA (10%), Clay (20%) & added glass of (5%) with Coarse Aggregate is yeilding higher strength compared to the conventional Concrete. There are many reasons behind it, as mentioned in the above chapters showing the mechanism & Effects of RHA with Cement, it is clear that RHA is a pozzalanic Material as per IS & ASTM, the chemical Compostion of Powdered Clay & Glass also takes the credits. It is also Observed that the increase in RHA to 20% i.e (Mix 2) & not changing the other two components, leads to the decrease in the strength, this is because of much replacement of Materials which effects the binding Factor of Cement & Aggregates. The Main Advantage of RHA replacement by 10% shows high strength growth by 33% when compared to conventional Concrete on 28^{th} Day.

It Concludes that Mix 1 can not only be Used to get a considerable increment in Concrete Mix but also Reduces the amount of cement in the Mix which in turn reduces the green house gas emmisions. About 100 million tons of Rice husk is produce worldwide. Their bulk density ranges from 90 to 150 kg/m3. As a result, the dry volume value increases. The surface of the rice husk is extremely rough and abrasive. As a result, they are resistant to natural deterioration. This would lead to issues with incorrect disposal. The greatest sustainable solution is to find a way to turn these byproducts into a new product.

However, further researches on durability & other aspects of the eco-friendly green materials replaced concrete is required to suggest these materials for sustainable concrete practices.

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