Strength and Durability Study of Concrete by Using Rice Husk Ash and Coconut Fiber

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Abstract: This project based on use of Rice Husk Ash as a replacement of cement content. rice husk ash a waste material. This waste material rice husk ash contain SiO_2 use for their characteristic like optimum strength, good durability etc. rice husk ash is an agro waste and known to be a super pozzolona have been used for mass concrete. Due to quick urbanization there is a rapid development of tall building and long span concrete structures. Fibers increase the flexural toughness and increase shatter and abrasion resistance, improving concrete long term durability and integrity. The new composite made by coconut fiber and rice husk ash possess superior properties in terms of strength, cohesion, low permeability and enhanced chemical resistance and at the same time reduce shrinkage cracking too. The topic entitled "strength and durability study of concrete by using Rice Husk Ash and Coconut Fiber" comprise the development of concrete using different range of RHA and coconut fiber. The present study is carried out for evaluating the influence of Rice-husk ash and Coconut fibers in M30, M40 and M50 grade concrete. This study presents the results of workability, compression test, durability test and split tensile test on concrete which were casted with various percentage of Coconut fibers ranging from 0% to 4% at a regular interval of 1% and Rice-husk ash ranging from 0% to 30% at regular interval of 10%. Total 27 mix will designs considered and average result of 3 cubes and 3 cylinders was taken as compressive strength and tensile strength of that mix design.

Keywords: Coconut Fiber, Rice husk ash, Green concrete, Workability, Strength, Durability

I. INTRODUCTION

The concept of environmentally friendly technology has inspired the researchers to do more in protecting the environment. Utilization of waste materials as alternative building materials has become the popular way to overcome the environmental problem in most developing countries. Waste materials such as Rice Husk have great potential to be used as building materials. The high silica content from Rice Husk Ash has pozzolanic behaviour which influence the concrete strength [2].

The annual production of rice from across the globe is around 600 million tons per year. Thailand alone produces approximately 5 million tons annually. The outer shell of rice grain, often called as rice husk, generated from the rice milling industries is a well-known agro industrial by-product in many parts of the world. Raw rice husk (RRH) consists of about 40% cellulose, 30% lignin group and 20% silica. The RRH normally used as a fuel in the parboiling process in rice milling industries. On combustion, the cellulose–lignin matrix of RRH burns away and leaves only a porous silica skeleton. Therefore, RHA contains a large volume of silica. After grinding the porous silica skeleton of rice husk a fine powder with high surface area, called rice husk ash (RHA). Due to its high silica content, RHA is considered as a highly reactive pozzolanic material in the production of concrete. The reactivity of RHA is attributed to the high amorphous silica content and the very large surface area governed by the porous structure of the particles. Highly reactive RHA is found when it is burnt under controlled conditions. The RHA contains high silica content in the amorphous form of silica up to 95% or even 100%. Its reactivity is also favored by increasing its fineness [11].

The enhancement in the mechanical properties and durability of concrete due to the addition of RHA is caused by the reaction of RHA with $Ca(OH)_2$ during the hydration process to form additional C–S–H gel. It was confirmed by the findings of Yu et al. that at temperatures around 40 ^{0}C and in the presence of water, the amorphous silica contained in RHA can react with $Ca(OH)_2$ to form one kind of C–S–H gel ($Ca_{1.5}SiO_{3.5}$. xH_2O) [17].

In other conditions, a residual RHA is produced with a lower quality due to high carbon content. The high carbon content leads to an increase in water demand and produces a darker color in mortar and concrete. However, the filler effect has been demonstrate as being even more pronounced than the pozzolanic effect [8].

Coconut fibre is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fibre were coir, cocos nucifera and arecaceae (Palm), respectively. There were two types of coconut fibres, brown fibre extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance, while white fibres are smoother and finer, but also weaker. Coconut fibres are commercially available in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). These different types of fibres have different uses depending upon the requirement. In engineering, brown fibres are mostly used. According to official website of International Year for Natural Fibres approximately, 500,000 tonnes of coconut fibres were produced annually worldwide, mainly in India and Sri Lanka. Its total value is estimated at $100 million. India and Sri Lanka are also the main exporters, followed by Thailand, Vietnam, the Philippines and Indonesia. Around half of the coconut fibres produced is exported in the form of raw fibre [10].

Coconut fiber, extracted from the husk of coconuts, was cheap and locally available in many tropical and semitropical countries. Coconut fiber was capable of taking strain 4–6 times as compared to other natural fibers. The potential of using coconut fiber to improve the performance of cementitious materials has received increasing attention from researchers in recent years. Coconut fiber was currently widely used in boards, roofing materials, concrete, and other building materials. Cementitious composites that have been reinforced with coconut fiber and cast under 1–2 MPa of pressure are presently used as low-cost roofing materials. Previous research has found that coconut fiber reinforced cementitious mixtures exhibit decreased workability due to the strong water absorptive and retentive nature of coconut fiber [5].

II. LITERATURE REVIEW

Ade Sri Wahyuni et al. [2] carried out an experimental research on the performance of concrete with rice husk ash, sea shell ash and bamboo fiber addition. The aim of that research was to investigate the tensile strength of concrete with 0.50% addition of bamboo fibre based on cement weight. To increase the strength of concrete, the mixture of rice husk ash (RHA) and sea shell ash (SSA) was used as partial replacement of fine aggregate. Their replaced was divided into four different percentages namely 10%, 20%, 30% and 40% based on the weight of fine aggregate. The experimental work consisted of casting 13 different types of concrete to be compared in term of splitting tensile strength at the age of 28 and 90 days. In general, the tensile strength of bamboo fibre reinforced concrete is comparable to that of Normal Concrete. It was clear from the graph that the tensile strength of 20% replaced by RHA was higher than that of normal concrete by age of 28 days.

M. Jamil et al. [11] experimentally studied the Pozzolanic contribution of rice husk ash in cementitious system. Replacement percentages of RHA used in various previous studies were chosen arbitrarily like 5%, 10%, 20% and so on to determine the total effect of RHA. But the unique filler effect or pozzolanic effect of RHA in cementitious system was yet to be investigated comprehensively by the scientific community. The study was carried out to find the maximum pozzolanic (chemical) contribution of RHA in cementitious system in terms of replacement percentage. The determination was analytical and based on the hydration reaction of cement and the pozzolanic reaction of RHA with the hydration product. They achieved 42.5N/mm^2 compressive strength at 20% Replacement compared to 37.1 N/mm^2 Compressive strength of normal concrete.

S.N. Raman et al. [17] carried out an experimental research on high-strength rice husk ash concrete incorporating quarry dust as a partial substitute for sand. The experimental work undertaken to evaluate the suitability of quarry dust as a partial substitute for sand in high-strength concrete (HSC) containing rice husk ash (RHA). Two grades of HSC mixes, to achieve 60 MPa and 70 MPa at 28 days, were designed with and without the incorporation of RHA. Quarry dust was then used in the mixes containing RHA as a partial substitute for sand, in quantities ranging from 10% to 40%. They achieved compressive strength higher at 10% replacement compared to compressive strength of normal concrete. Similarly, 10% RHA was used to replace the cement in the remaining mixes with mixes contains quarry dust as a replacement for sand at 10%, 20%, 30% and 40% respectively decrease the compressive strength then use only RHA.

Divya chopra [7] experimentally studied about Strength, permeability and microstructure of self-compacting concrete containing rice husk ash. Self-compacting concrete (SCC) was characterized by deformability and segregation resistance. It flows under its own weight while remaining homogeneous in composition. The effect of replaced cement content with rice husk ash (RHA) as supplementary cementitious materials (SCM's) in SCC and observing fresh flow (slump flow, V-Funnel, U-box, L-Flow), mechanical strength (compressive and split tensile) and durability properties (porosity and rapid chloride permeability test) at 7, 28 and 56 d. Concrete specimens were prepared with 0,10, 15 and 20% RHA replace cement. 20% RHA replaced showed minimum specified workability. An increase of about 25% strength at 7 d, 33% at 28 d and 36% at 56 d was observed with RHA content of

15% RHA when compared to control mix. Maximum split tensile strength was 3.8 N/mm^2 at 28 d and 4.0 N/mm^2 at 56 d for 15% RHA replacement. The inclusion of RHA as partial replaced to cement improved the strength properties and durability properties that remained within limits up to 20% replaced.

Hwang Chao-Lung et al. [8] carried out the research work on effect of rice husk ash on the strength and durability characteristics of concrete. The work investigated the effects of adding residual rice husk ash (RHA) from South Vietnam, generated when burning rice husk pellets in the boiler, to cement. To improve pozzolanic reactivity, RHA was ground for 1 h. The non-ground RHA and ground RHA were used to test strength activity index according to ASTM C311. The properties of the concrete were investigated, including compressive strength, concrete electrical resistivity, and ultrasonic pulse velocity. Results showed that the non-ground RHA can be applied as a pozzolanic material. Decreasing the non-ground RHA average particle size provides a positive effect on the compressive strength of mortar. Compressive strength of cylindrical concrete in the 47–66 MPa range was obtained in this study. The results also indicated that up to 20% of ground RHA could be advantageously blended with cement without adversely affecting the strength and durability properties of concrete. The achieved compressive strength 66 N/mm2 AT 10% Replaced compared to 56 N/mm2 Compressive strength of normal concrete. Same replaced RHA but increase w/b ratio result decrease strength.

Saeid Hesami et al. [15] carried out the research work on effects of rice husk ash and fiber on mechanical properties of pervious concrete pavement. The use of pervious concrete pavement was significantly increasing due to reduction of road runoff and absorption of noise. However, the type of pavement cannot be used for heavy traffic due to a high amount of voids and consequently low strength of pervious concrete. The rice husk ash (RHA) was used in order to strengthen pozzolanic cement paste and the effect of 0%, 2%, 4%, 6%, 8%,10% and 12% weight percentages as a cement replaced in concrete mixtures on the mechanical properties was studied. Moreover, 0.2% Vf of glass (where Vf is the proportion of fiber volume to total volume of concrete), 0.5% Vf of steel and 0.3% Vf of polyphenylene sulfide (PPS) fibers were used to improve the mechanical properties of the pervious concrete. Also, several water to cement (w/c) ratios were made and then, physical and mechanical properties of hardened concrete including porosity, permeability, compressive strength, tensile strength and flexural strength were investigated. The results indicated a significant increase in compressive, tensile and flexural strengths. Also, in all of w/c ratios, a similar trend was observed in the compressive, tensile and flexural strengths of concrete containing RHA and fibers but the optimum percentage of RHA was different so that, it increases rapidly to the optimization point but gradually decreases after this point. The w/c ratio of 0.33 significantly increased the mechanical properties of the pervious concrete and reduces the amounts of voids and its permeability.

Chao-Lung Hwang et al. [5] carried out the study on effects of short coconut fiber on the mechanical properties, plastic cracking behavior, and impact resistance of cementitious composites. The study examines the effect of adding random, short coconut fibers to various cementitious composites on the mechanical properties, plastic cracking, and impact resistance of these composites. Fibers underwent a washing and boiling pre-treatment prior to being added to the composite mixture. Mixtures of the cementitious composites designed by Densified Mixture Design Algorithm (DMDA) method were made using different volume fractions of random, short coconut fiber (0%, 1%, 2.5%, and 4%) and different water-to-binder (W/B) ratios (0.3, 0.35, and 0.45). Furthermore, fly ash (FA) was used to fill the void between sand particles and ground blast furnace slag (GBFS) was used to substitute for the cement in the mix proportions. A variety of tests were conducted in accordance with the relevant standards to determine the properties of these coconut fiber cementitious composites. The findings show that higher volumes of coconut fiber in the mortar tend to reduce the density and to increase the superplasticizer dosage. The addition of coconut fiber and higher W/B ratios were associated with lower compressive strength and higher absorption. The 28-day flexural strength of cementitious sheets and the modulus of rupture, respectively, increased from 5.2 to 7.4 MPa and from 6.8 to 8.8 MPa, as the coconut fiber- to-mortar ratio ranged from 0% to 4%. Adding coconut fiber positively influenced first-crack deflection, toughness indices, plastic cracking, and impact resistance in the composites.

Majid Ali et al. [10] carried out study on mechanical and dynamic properties of coconut fibre reinforced concrete. Coconut fibres havethe highest toughness amongst natural fibres. They have potential to be used as reinforcement in low-cost concrete structures,especially in tropical earthquake regions. For this purpose, the mechanical and dynamic properties of coconut fibre reinforced concrete (CFRC) members need to be well understood. In the work, in addition to mechanical properties, damping ratio and fundamental frequency of simply supported CFRC beams were determined experimentally. A comparison between the static and dynamic moduli was conducted. The influence of 1%, 2%, 3% and 5% fibre contents by mass of cement and fibre lengths of 2.5, 5 and 7.5 cm was investigated. To evaluate the effect of coconut fibres in improving the properties of concrete, the properties of plain concrete were used as a reference. Damping of CFRC beams increases while their fundamental frequency decreases with structural damage. CFRC with higher fibre content has a higher damping but lower dynamic and static modulus of elasticity. They were found that CFRC with a fibre length of 5 cm and a fibre content of 5% has the best properties.

M. Sivarajas. Kandasamy[12] carried out the study on Potential reuse of waste rice husk as fibre composites in concrete. The aim of that paper was to characterize the structure related properties of concrete composite with locally available rice husk fibers, for achieving reasonable energy absorbing capacity. Experimental investigations were performed to find the mechanical, shear, impact and flexural properties of concrete with and without rice husk composites. Microstructure of as received and reacted rice husk fibers with concrete for two years are also studied for durability considerations. The achieved tensile strength of 3.48 N/mm2 and compressive strength 27.98N/mm2 at 1.5% replacement compared to 2.86 N/mm2 Tensile strength and 27 N/mm2 Compressive strength of normal concrete.

III. MATERIALS AND METHODS

A. *Materials*

1) *Cement:* The OPC used in the study was mixed with water and materials such as sand and coarse aggregates of various sizes to make concrete. Grade 53 Ultra Tech cement was used for casting cubes and cylinders for all concrete mixes. Testing of cement was conducted as per IS: 8112 (1989) and the results are reported in Table 1.

Table 1- Basic Test Conducted on ordinary Portland Cement.

Properties	Result
Specific gravity	3.12
Fineness test	0.95%
Soundness test	1.4
Consistency	32.5%
Initial setting time	135 minute
Final setting time	245 minute
Compressive strength (3 days)	29.46 N/mm^2
Compressive strength (7 days)	43 N/mm^2
Compressive strength (28days)	53 /mm^2

2) *Fine and Coarse Aggregate:* The sand used for the experiments was locally procured and conformed IS: 383 (1970). The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm, locally available coarse aggregates having the maximum size of 20 mm was used in the present work. Testing of fine and coarse aggregates were done as per IS: 383 (1970).
3) *Rice Husk Ash:* Rice Husk ash having pozzolanic properties would reduce the demand of Portland cement and thus it should reduce unit cost of concrete. Meanwhile, the ash has been categorized under pozzolana, with about 85% silica and about 4.9% and 0.95% Alumina and iron oxides, respectively. Physical properties are shown in Table 2. Chemical properties of the RHA are shown in Table 3.

Table 2: - Physical Properties of Rice-husk Ash

Physical state	Solid Non-Hazardus
Appearance	Very fine powder
Colour	Grey
Odour	Odourless
Particle size	25 micron – mean
Specific gravity	2.3

Table 3: - Chemical Properties of Rice-husk Ash

SiO_2	90.8 %
AL_2O_3	0.34 %
Fe_2O_3	0.70 %
CaO	0.59 %
Na_2O	0.28 %
K_2O	0.32 %
Loi	3.37

4) *Coconut Fiber:* Coconut fibre is extracted from the outer shell of a coconut. There are two types of coconut fibres, brown fibre extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance. White fibres are smoother and finer, but also weaker. Physical properties are shown in Table 4.



Table 4: - Mechanical Properties of Coconut Fiber

PROPERTIES	VALUES
Fiber length(mm)	50
Fiber diameter(mm)	0.20
Specific Gravity	1.12

5) *Superplasticizer:* The lignosulphonates based super plasticizer of brand REDWOP product ID “PLASTCONE AP211” water reducing concrete admixture was used which was light brown in color. It was satisfied as per IS 9103- 1999. Superplasticizer dose used 0.6% by cement weight.

B. Final Mix Proportion

Table 5: - Mix Proportion 1 Cubic Meter Concrete M30 Grade

GRADE	VOLUME OF CEMENT	WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE (20mm)
M30	1 m^3	169.8	394.32	787.4	1143.72
		0.43	1	1.99	2.90

Table 6: - Mix Proportion 1 Cubic Meter Concrete M40 Grade

GRADE	VOLUME OF CEMENT	WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE (20mm)
M40	1 m^3	169.8	426.3	766.1	1137.6
		0.40	1	1.79	2.66

Table 7: - Mix Proportion 1 Cubic Meter Concrete M40 Grade

GRADE	VOLUME OF CEMENT	WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE (20mm)
M50	1 m^3	169.8	450.7	750.9	1131.8
		0.37	1	1.66	2.51

C. Test Methods

1) *Fresh Concrete Properties:* A concrete mix requirement of all three characteristics i.e. filling ability, passing ability and segregation resistance are fulfilled. To fulfil these requirements basic tests are conducted are slump flow test is carried out. Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. The slump test is used for the measurement of a property of fresh concrete as per IS: 1199 - 1959.
2) *Mechanical Properties:* Compressive strength (cube 150 x 150 x 150 mm) and split tensile strength (cylinder 150 x 300 mm) was determined at the age of 28 d in triplicates. They were tested according to IS: 516 (1959) and IS: 5816 (1999), respectively.
3) *Durability aspects:* The investigated durability aspects are carried out acid attack and chloride attack. For both the test 150 x 150 x 150 mm cubes were cast and sliced to 150 x 150 x 150 mm cubes. Both these tests were performed according to code for 56 d.

IV. RESULTS AND DISCUSSION

According to experiment program casting was done. General and basic test were carried out on cement and aggregate. Using the result of grading of aggregate and specific gravity of aggregate mix design M30, M40 and M50 was done manually according to IS 10262: 1987. This study presents the results of workability, compression test, durability test and split tensile test on concrete which were casted with various percentage of Coconut fibers ranging from 0% to 4% at a regular interval of 1% and Rice-husk ash ranging from 0% to 30% at regular interval of 10%. Total 27 mix will designs considered and average result of 3 cubes and 3 cylinders was taken as compressive strength and tensile strength of that mix design.

Rice husk ash replacement with cement proportion is 10%, 20%, 30% respectively. Then determine optimum dosage of RHA for all grade concrete carried out by casting of cubes and testing after 28 d of curing. The maximum compressive strength is achieved for percentage of RHA replacement by cement weight is called optimum dosage of RHA. optimum dosage of RHA for M30, M40 and M50 Grade Concrete are 15%, 10%, 5% respectively. The optimum dosage of rice husk ash, we will fix that dosage for next ternary mixes. optimum dosage of rice husk ash with coconut fibers by concrete volume proportion coconut fiber is 1%, 2%, 3%, 4% respectively.

A. Slump test

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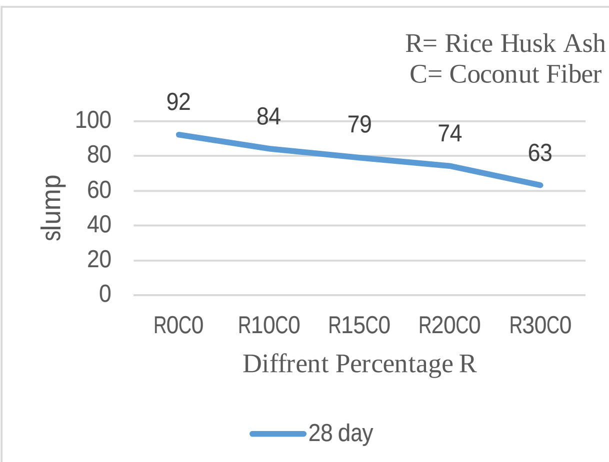
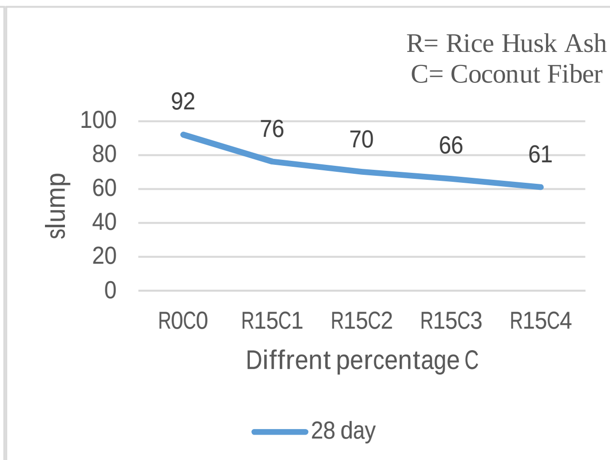
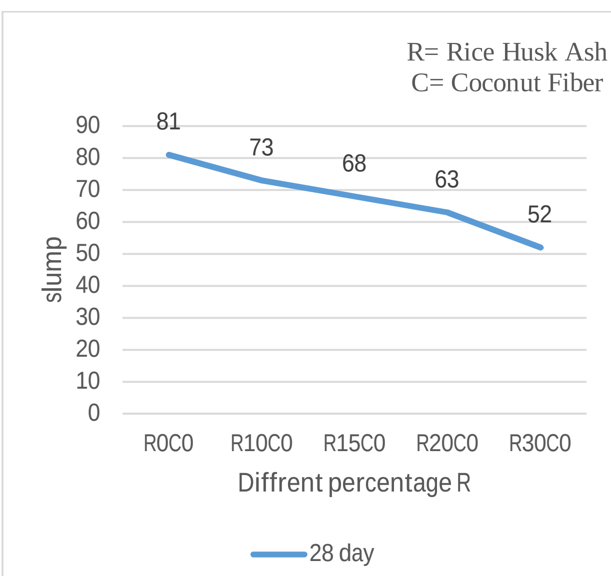
Fresh properties results showed that with increase in amount of RHA and CF workability decreased for all grade of concrete. It was observed that the concrete with RHA and CF requires increasing water cement ratio because of RHA is highly porous material and CF is more adsorb water.



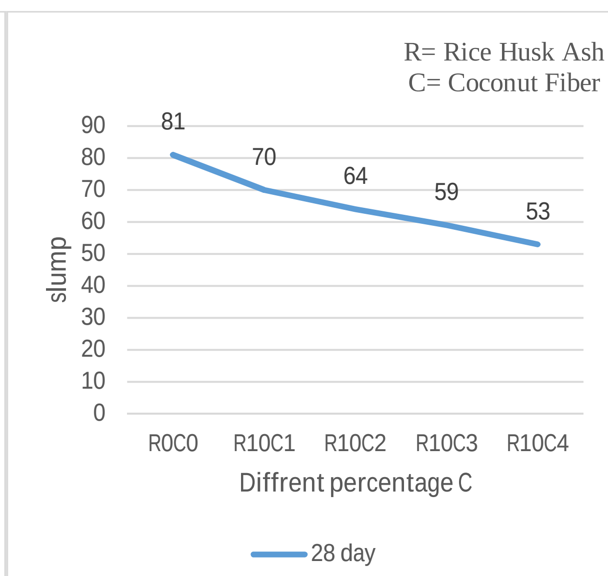
M30 Grade (Only RHA)



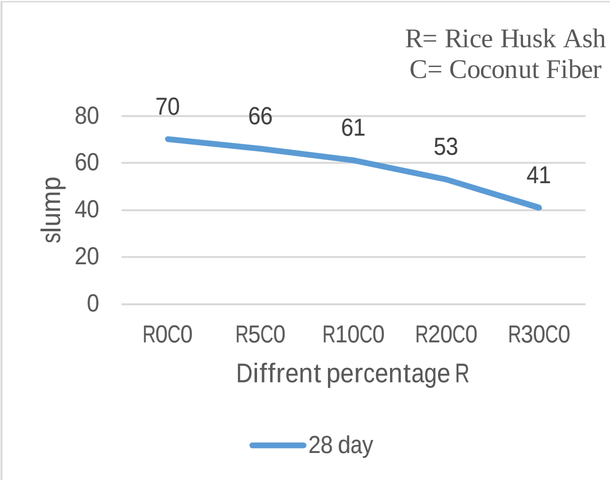
M30 Grade (15% RHA and Different percentages of CF)



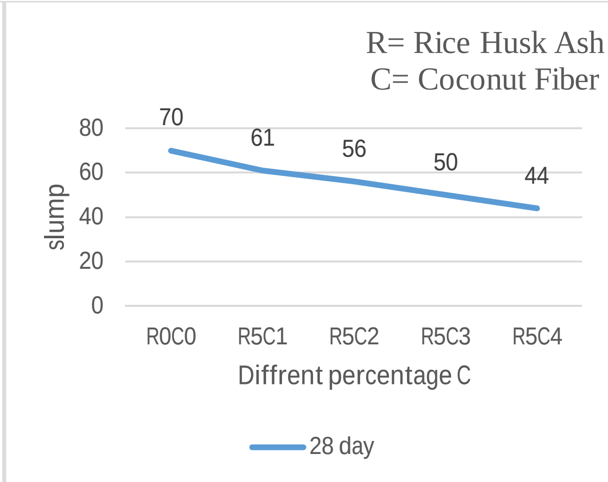
M40 Grade (Only RHA)



M40 Grade (10% RHA and Different percentages of CF)



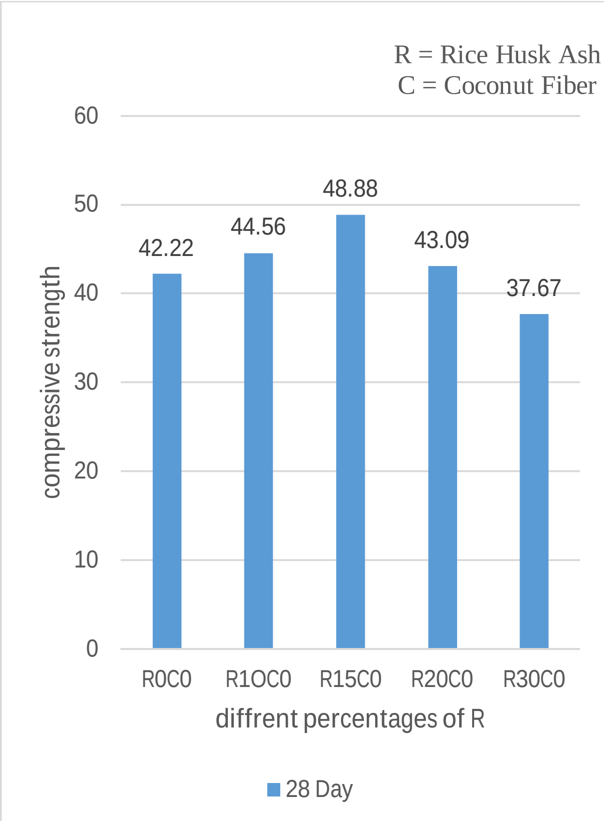
M50 Grade (Only RHA)



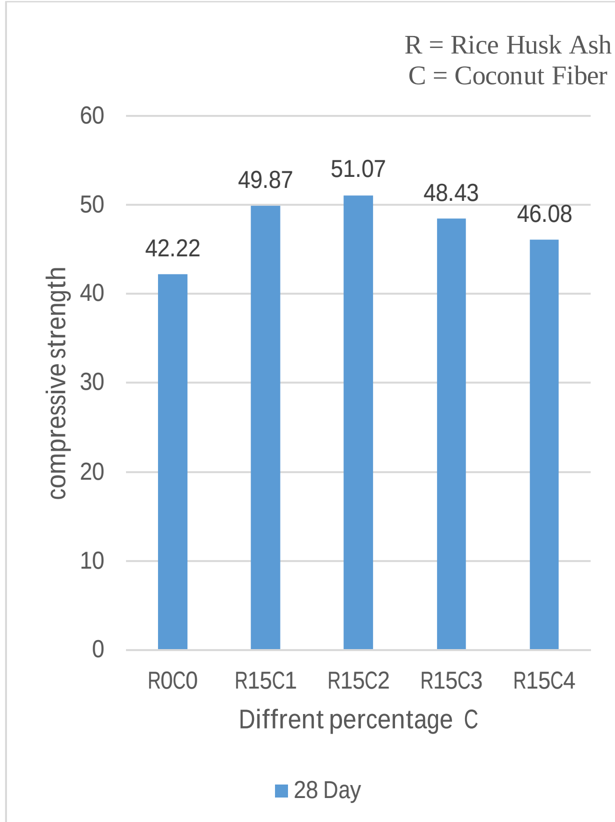
M50 Grade (5% RHA and Different percentages of CF)

B. Compressive strength

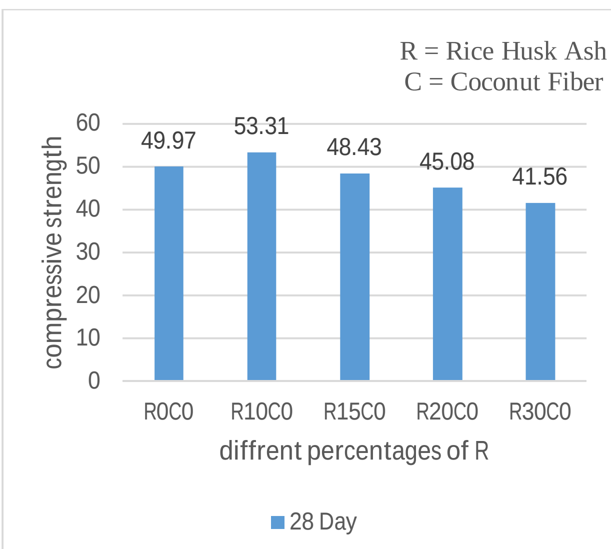
The highest strength is obtained by the mix 15% RHA (R15C0) 28 d ages for M30 Grade Concrete. Graphs shows that the Compressive strength increases with increase in percentage of RHA up to 15% replacement. There was decrease in strength for mix,20% RHA, but the values were still higher than control mix and then 30% RHA, but the values were still lower than control mix. Now optimum value 15% RHA fixed with coconut fiber additive by concrete volume percentages of 1%, 2%, 3% and 4%. Then highest strength is obtained by the mix 15% RHA and 2% coconut fiber (R15C2) for M30 Grade Concrete. Similarly, the highest strength is obtained by the mix 10% RHA (R10C0) 28 d ages for M40 Grade Concrete. Now coconut fiber additive by concrete volume then achieve highest strength is obtained by the mix 10% RHA and 2% coconut fiber (R10C2) for M40 Grade Concrete. Similarly, the highest strength is obtained by the mix 5% RHA (R5C0) 28 d ages for M50 Grade Concrete. Now coconut fiber additive by concrete volume then achieve highest strength is obtained by the mix 10% RHA and 1% coconut fiber (R10C1) for M50 Grade Concrete.



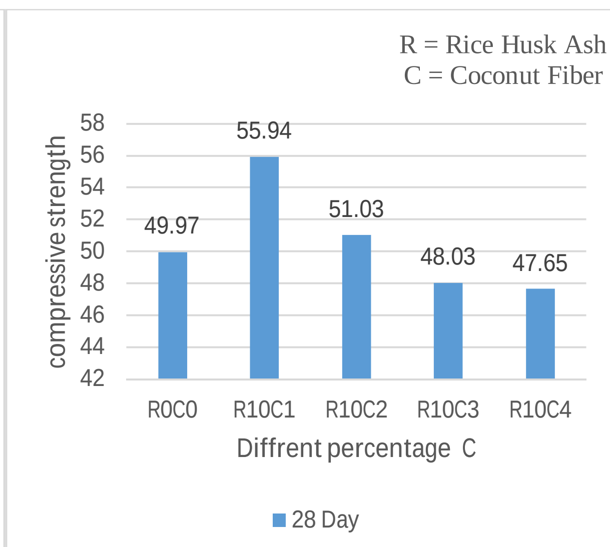
M30 Grade (Only RHA)



M30 Grade (15% RHA and Different percentages of CF)



M40 Grade (Only RHA)



M40 Grade (10% RHA and Different percentages of CF)

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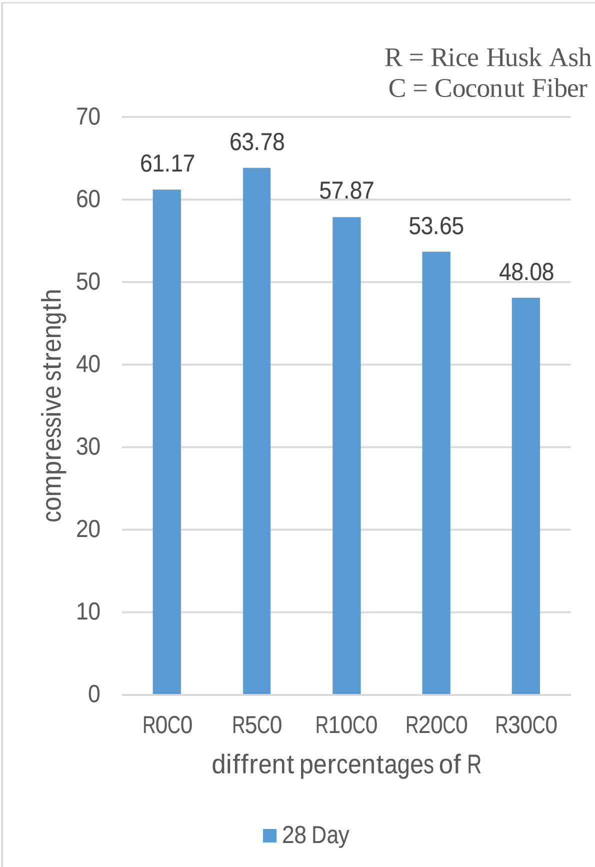
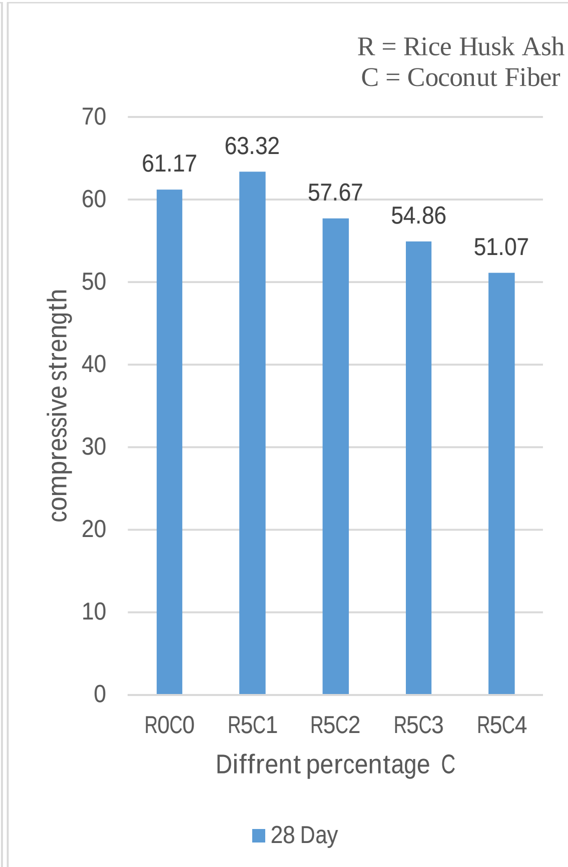


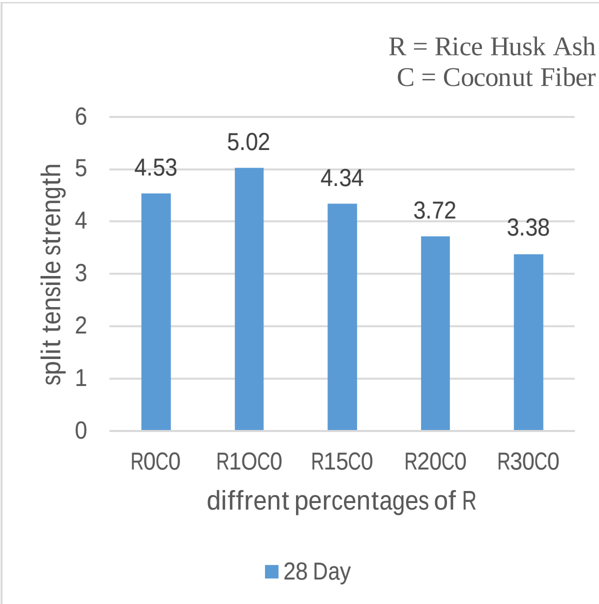
M50 Grade (Only RHA)



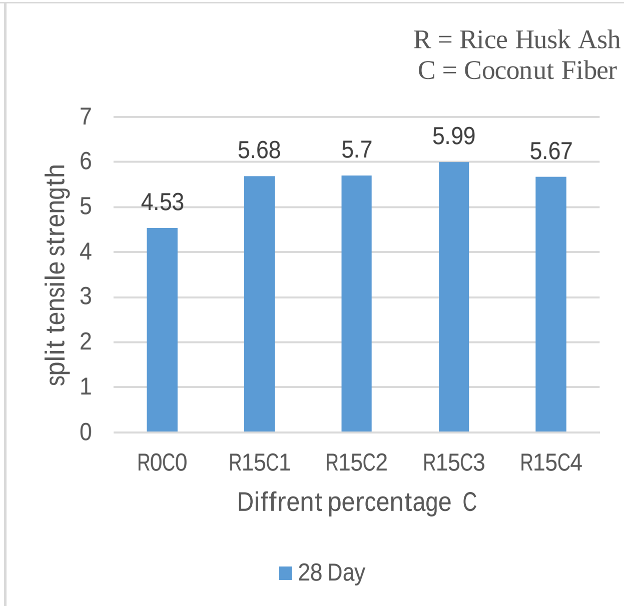
M50 Grade (5% RHA and Different percentages of CF)

C. Split Tensile Strength

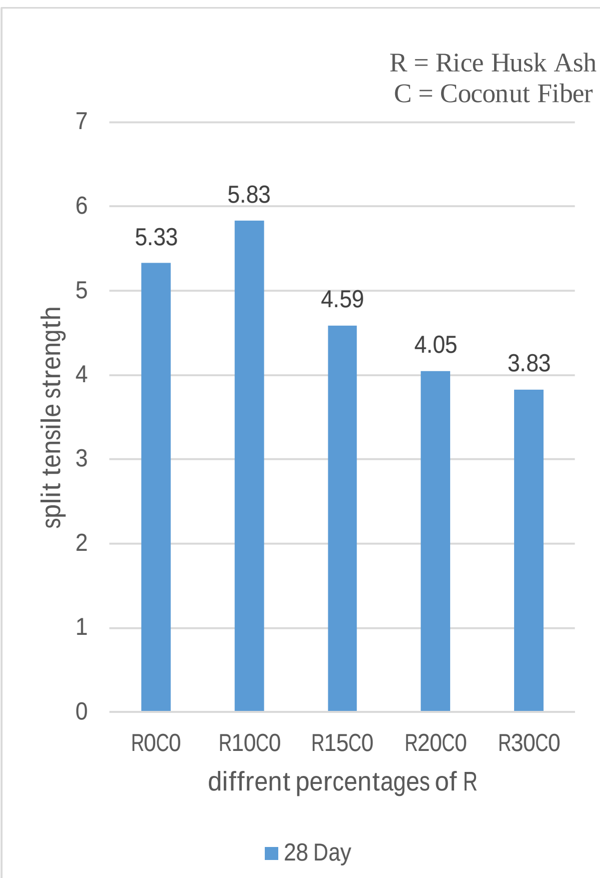
The split tensile strength uses of only RHA minimum percentages increase strength compare to control mix. Now RHA with coconut fiber additive by concrete volume percentages of 1%, 2%, 3% and 4% then split tensile strength maximum percentage increase strength compare to control mix. Then highest strength is obtained by the mix 15% RHA and 3% coconut fiber (R15C3) for M30 Grade Concrete. Similarly, the highest strength is obtained by the mix 10% RHA and 2% coconut fiber (R10C2) for M40 Grade Concrete. Similarly, the highest strength is obtained by the mix 5% RHA and 2% coconut fiber (R10C2) for M50 Grade Concrete.



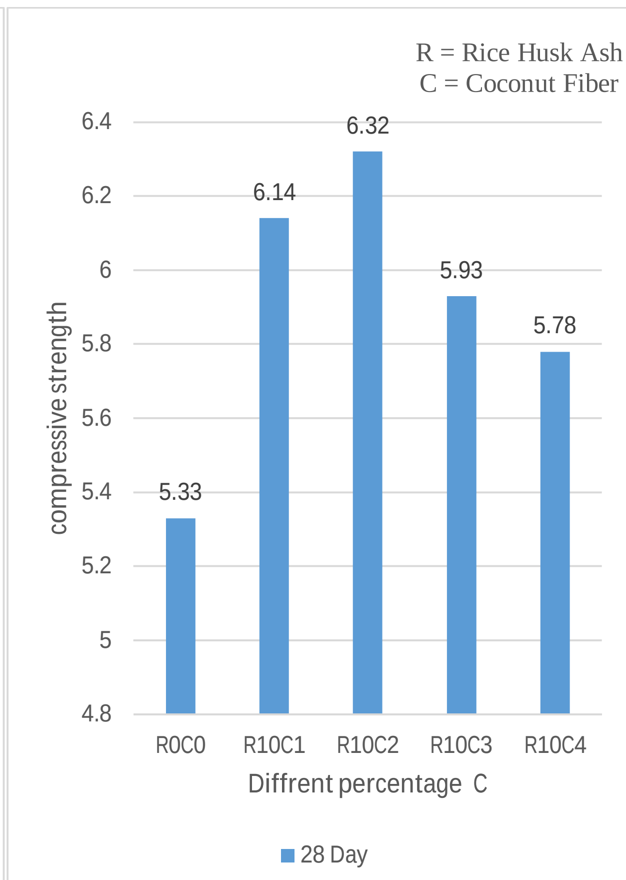
M30 Grade (Only RHA)



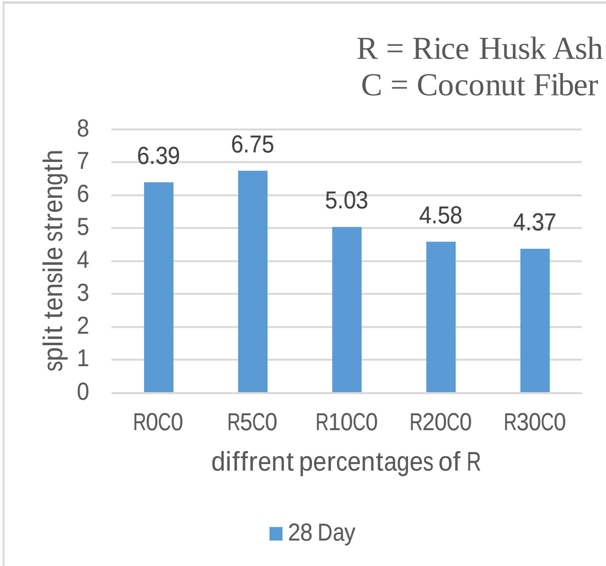
M30 Grade (15% RHA and Different percentages of CF)



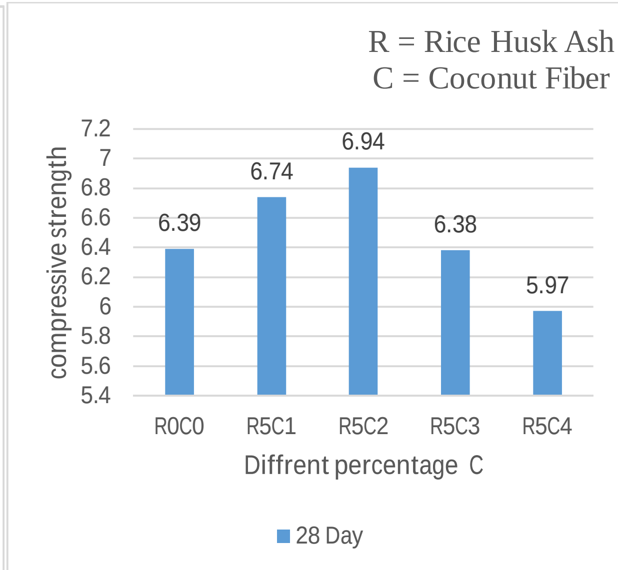
M40 Grade (Only RHA)



M40 Grade (10% RHA and Different percentages of CF)



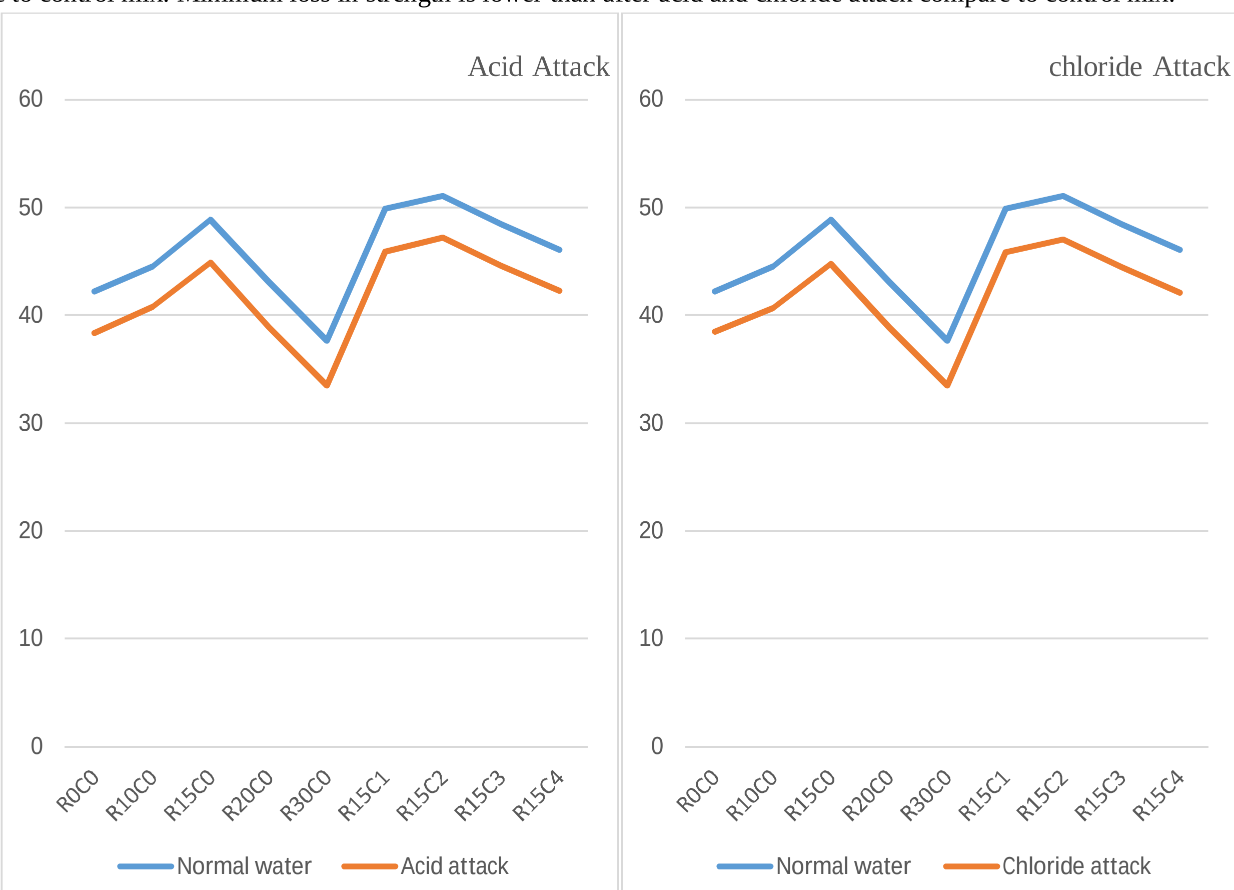
M50 Grade (Only RHA)



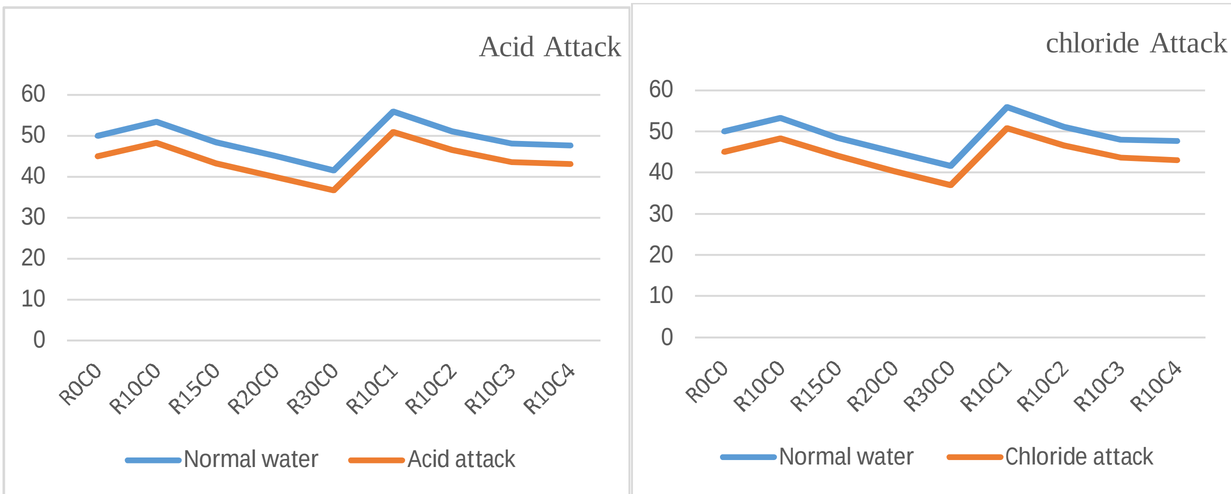
M50 Grade (5% RHA and Different percentages of CF)

D. Durability Aspects

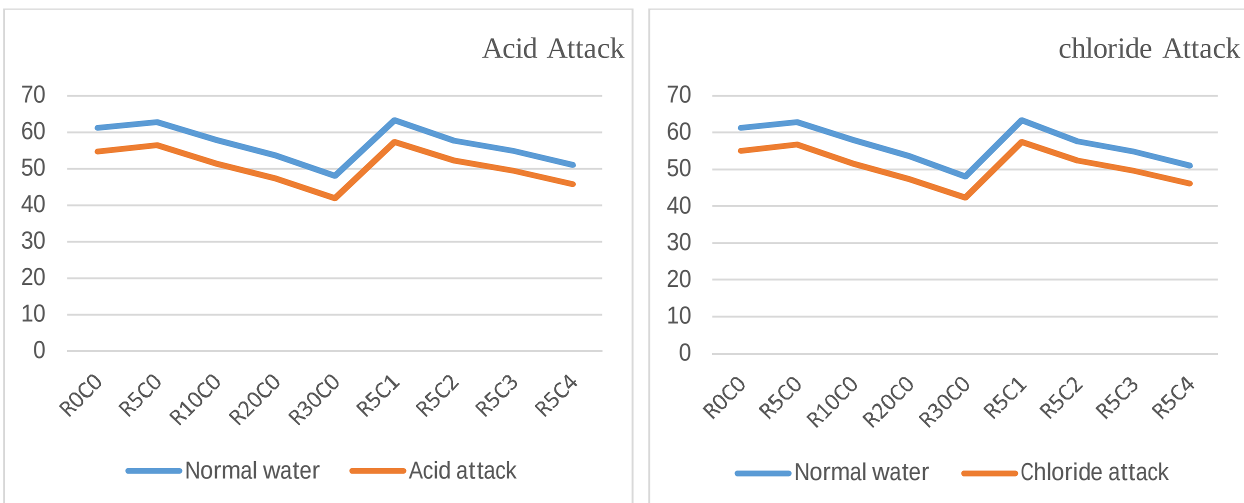
To conduct this test, 5% by volume of sulphuric acid was mixed with ordinary potable water. A solution of sodium chloride (NACL) was prepared in which 5% by weight of sodium chloride was mixed with ordinary portable water. The specimens were cured for 28 days in ordinary portable water and then immersed in the solution for a period of 56 days. To achieve best durability, compare to control mix. Minimum loss in strength is lower than after acid and chloride attack compare to control mix.



M30 Grade Compressive Strength for Normal Water Vs loss of Strength in after attack



M40 Grade Compressive Strength for Normal Water Vs loss of Strength in after attack



M50 Grade Compressive Strength for Normal Water Vs loss of Strength in after attack

V. CONCLUSIONS

A. Fresh properties results showed that with increase in amount of RHA and CF workability decreased for all grade of concrete.

B. It was observed that the concrete with RHA and CF requires increasing water cement ratio.

C. It is also found that the compressive strength and split tensile strength both are reduces in concrete with the replacement of RHA and CF from lower grade to higher grade.

D. It was observed that the RHA increases the compressive strength of concrete and CF increase the tensile strength of concrete.

1) For M30 Grade:

a) The compressive strength of concrete with 15% of RHA and 2% of CF replacement with cement increase about 21% in comparison with normal concrete.

b) The split tensile strength of concrete with 15% of RHA and 3% of CF replacement with cement increase about 32.2% in comparison with normal concrete.

c) In mixes 15% of RHA and 2% of CF replacement with cement gives minimum compressive strength loss with acid curing 56 day was 17.8% and chloride curing 56 days was 11.3% with respect to normal water curing 28 days.

2) For M40 Grade:

a) The compressive strength of concrete with 10% of RHA and 1% of CF replacement with cement increase about 12% in comparison with normal concrete.

b) The split tensile strength of concrete with 10% of RHA and 2% of CF replacement with cement increase about 18.6% in comparison with normal concrete.

c) In mixes 10% of RHA and 2% of CF replacement with cement gives minimum compressive strength loss with acid curing 56 day was 12.5% and chloride curing 56 days was 11% with respect to normal water curing 28 days.

3) For M50 Grade:

a) The compressive strength of concrete with 5% of RHA and 1% of CF replacement with cement increase about 3.5% in comparison with normal concrete.

b) The split tensile strength of concrete with 5% of RHA and 2% of CF replacement with cement increase about 8.6% in comparison with normal concrete.

c) In mixes 5% of RHA and 2% of CF replacement with cement gives minimum compressive strength loss with acid curing 56 day was 9.7% and chloride curing 56 days was 9.6% with respect to normal water curing 28 days.

VI. FUTURE SCOPE

A. Further work also can be carried out by another durability test which are remaining and check the durability.

B. Further research can develop on other supplementary materials and fiber using in concrete.

C. Compressive strength can be verified weather it is suitable in lower grade of concrete with the use of rice husk ash and coconut fiber.

D. Flexural strength can be checked for concrete using by rice husk ash and coconut fiber.

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