iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.53617

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

An Experimental Study on Strength of Concrete Using Areca Nut Husk Fiber and Partial Replacement of Cement by Granite Powder

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Abstract: ***In this experimental investigation, various concrete mixtures were prepared by replacing cement with GP at different percentages (10%, 20%, 30%). Additionally, ANHF was added to the concrete mixtures in proportion 0.5% by weight of cube and cylinder to assess its impact on the mechanical properties of concrete. The properties examined included compressive strength and split tensile strength.***

The results of the experiments revealed that the inclusion of ANHF in the concrete mixture led to a significant improvement in the strength properties. Concrete specimens containing ANHF exhibited enhanced compressive and split tensile strengths compared to the control samples without ANHF. Furthermore, the addition of GP as a partial replacement for cement resulted in improved strength characteristics. The findings of this study highlight the potential of using waste materials such as ANHF and GP as viable alternatives in concrete production. The incorporation of ANHF can effectively enhance the strength properties of concrete, while the partial replacement of cement with GP offers both environmental and economic benefits. These results contribute to the sustainable development of the construction industry by reducing the reliance on conventional materials and promoting the utilization of waste by-products.

Keywords: Cement Areca Nut Husk Fiber, Granite Powder.

I. INTRODUCTION

The experimental study aims at modification of concrete by using locally available waste materials. The objective of this experiment is to observe the effect of the combination of areca fibers in concrete. Compressive, split tensile and flexural tests were conducted with the standard curing duration of 28 days. Areca fiber, which is an agricultural waste found abundantly in Kerala was collected from nearby local areas for our study.

A. Areca Nut Husk Fibers

With growing environmental awareness, new rules and legislations scientists and engineers are forced to seek new materials which are more eco-friendly in nature. Hence, the attention of the research community is focused toward finding an eco-friendly material which can give high performance at affordable costs. The keywords with which the eco-friendly materials focused are "biodegradable," "recyclable," "renewable" and "sustainable". Natural fiber composites are one such kind of materials. The usage of natural fibers in the composites is well-known, because of its inherited qualities such as lignocelluloses, renewable, and biodegradability. There are other several reasons that favor the use of natural fibers instead of any other artificial or synthetic fibers. They are lightweight materials having superior strength, competitive specific mechanical properties, high specific modulus, and reduced energy consumption. Further, they are nontoxic and non-hazardous in nature, naturally available in abundance, flexible in usage, less expensive and that allow clean energy recovery etc.

B. Granite Dust

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and less in the burden of pollutants on environment. Presently large amounts of granite dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the granite dust in concrete production as partial replacement of sand. In INDIA, the granite and granite stone processing is one of the most thriving industry the effects If varying granite dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated.

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How ever as the by-product i.e. the powder differs chemically depending on the parent granite rocks which depend on the locality, degree of metamorphism and other factors and also as the physical characteristics of the by-product depends on the polishing work.

II. OBJECTIVE OF THE STUDY

1) To introduce Areca nut husk fiber and granite powder in conventional concrete.
2) To vary the percentage of Areca nut husk fiber and granite powder in conventional concrete.
3) To compare conventional concrete with Areca nut husk fiber used in concrete in terms of different strengths of concrete by varying granite powder mass.
4) To find out optimum % of fiber content description of concrete specimen is presented in.
5) To reduce the consumption of cement by granite powder as a base material in concrete.
6) For formation of low cost concrete by using waste materials such as granite powder and areca fiber with replacement of cement.

III. LITERATURE REVIEW

1) AISHWARYA G et.al; Waste management is one of the major concerns in the modern world. This paper is intended for the utilization of waste materials such as areca fiber and ceramic tile powder in concrete in order to modify the strength properties. Nowadays, 15% to 30% production of ceramic tile goes as waste in tile industry. Areca fiber is one of the natural fibers which is abundantly produced as a waste material in many parts of South India, which is not properly utilized. Here we are utilizing tile powder as the partial replacement of cement by 30% of its weight. Areca fiber is added as a partial replacement of cement accordingly in the range of 0%, 1%, 2% and 3%by weight for M20 grade concrete. Various tests such as compressive strength, split tensile strength and flexural strength for 28 days were conducted. The test result shows that the compressive strength, flexural strength and split tensile strength of concrete increases with the increase in addition of areca fiber at different percentages.
2) SHEHDEH GHANNAM et.al; Granite Powder (GP) and Iron Powder (IP) are industrial byproducts generated from the granite polishing and milling industry in powder form respectively. These by-products are left largely unused and are hazardous materials to human health because they are airborne and can be easily inhaled. An experimental investigation has been carried out to explore the possibility of using the granite powder and iron powder as a partial replacement of sand in concrete. Twenty cubes and ten beams of concrete with GP and twenty cubes and ten beams of concrete with IP were prepared and tested. The percentages of GP and IP added to replace sand were 5%, 10%, 15%, and 20% of the sand by weight. It was observed that substitution of 10% of sand by weight with granite powder in concrete was the most effective in increasing the compressive and flexural strength compared to other ratios. The test resulted showed that for 10% ratio of GP in concrete, the increase in the compressive strength was about 30% compared to normal concrete. Similar results were also observed for the flexure. It was also observed that substitution of up to 20% of sand by weight with iron powder in concrete resulted in an increase in compressive and flexural strength of the concrete.
3) MD. ZAHIDUL ISLAM et.al; this study, the mechanical properties of the composites made of areca fibers as reinforcing agent with polyester matrix were evaluated. Both untreated and treated (mercerized) fibers were used to fabricate composites and the mechanical properties such as tensile strength (TS), tensile modulus (TM), flexural strength (FS), flexural modulus (FM) and impact strength (IS) of the composites were examined. Composites were manufactured by means of hand lay-up technique with varying fiber content (5 and 10%). Mechanical properties of plywood were also tested and compared with the composites. It was found that areca fiber composites showed significant improved mechanical properties than plywood. Among the composite materials 10% fiber loading presented higher mechanical properties than 5% fiber content and the treated fiber composites exhibited enhanced mechanical properties than the untreated fiber composites due to strong interfacial bonding between fiber and matrix. In addition, water uptake test was performed and specifies that areca composites absorbed very much lower amount of water than that of plywood. The morphology was investigated by scanning electron microscopy (SEM).

IV. CHARACTERISTICS OF MATERIALS

A. *Cement*

The cement used in this project is ordinary Portland cement which is 53 grade & the name of the cement is Coromandel king.

Table 1 chemical composition of ordinary Portland cement

Contents	Percentage

CaO	60-67
SiO2	17-25
Al2O3	3-8
Fe2O3	0.5-6
MgO	2.5
SO3	2-2.5
Other Oxides	5

Table 2 Physical composition of ordinary Portland cement

SL.No	Properties	Results
1	Normal consistency (%)	28
2	Specific gravity	3.1
3	Initial setting time (min)	60

B. Areca Nut Husk Fiber

Areca is an important commercial crop in India. India ranks first in the areca production in the world having around 4.78 hundred thousand tons of production per year. The husk were cleaned with water, dried in sunlight and incinerated in open furnace at a rate of 10°C per min up to 500°C for 6 hours to remove volatiles, then cooled for 10 hours and sieved through a 75 micron sieve for the test purpose.

Table 3 Chemical composition of Areca nut husk Fiber

Content	Percentage
cellulose	55.82%
hemicelluloses	34.28%
lignin	6.82%
moisture	1.80%
ash content.	1.28%

C. Granite Powder

Granite powder is an industrial by-product obtained from crushing of granite stone and granite stone polishing industry in a powder form. If left on its own and is not properly collected and stored, the fine granite powder can be easily be airborne and will cause health problems and environmental pollution.

Table 4 Physical Properties of Granite Powder

Sl.NO	Test parameter	Results %
1	Silica content (SiO2)	83.36
2	Alumina content (Al2O3)	8.02
3	Iron content (Fe2O3)	6.67
4	Calcium Oxide (CaO)	6.70
5	Magnesium Oxide (MgO)	4.20

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Table 5 Physical Properties of Granite Powder

Sl.No	Properties	Results
1	Specific Gravity	2.48

V. EXPERIMENTAL WORK

A. Mix Design

Design of M20 grade concrete
MIX PROPORTIONS

Cement	=426.66 Kg/m^3
Fine Aggregate	=675.16 Kg/m^3
Coarse Aggregate	=1088.76 Kg/m^3
Water	=192 Liters
Water Cement Ratio	=0.45 =0.5

VI. DETAILS OF THE SPECIMENS

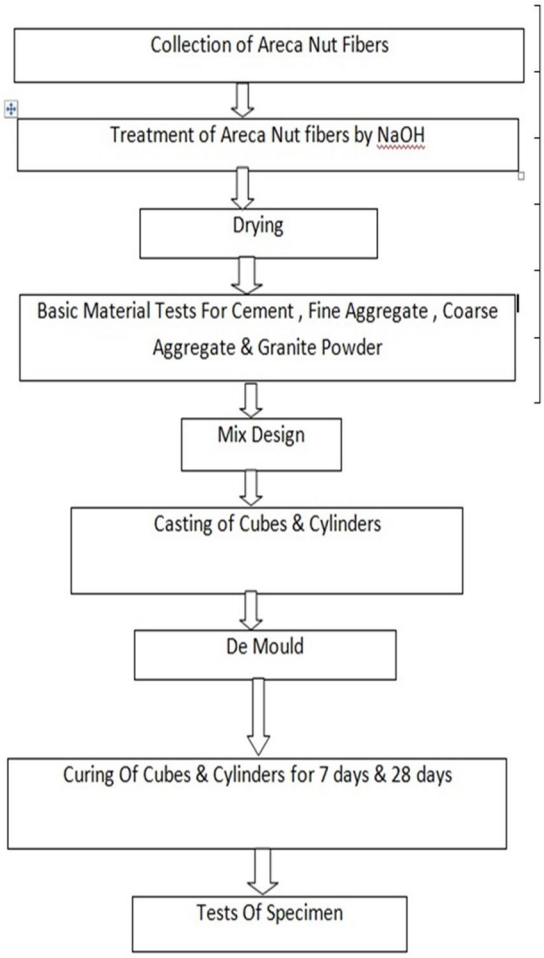
Table 6 Dimensions of the test specimens

SPECIMEN	CUBES		CYLINDERS	
DIMENSION	(150*150*150) mm		150 mm Diameter & 300 mm height	
SAMPLE/NO OF DAYS	7 DAYS	28 DAYS	7 DAYS	28 DAYS
A	3	3	3	3
B	3	3	3	3
C	3	3	3	3
D	3	3	3	3
TOTAL	12	12	12	12

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VII. METHODOLOGY



VIII. PREPARATION OF TESTING SPECIMEN

MIXING

Mixing of ingredients is done in pan mixer of capacity liters. The cementitious materials are thoroughly blended and then the aggregate is added and mixed followed by gradual addition of water and mixing. Wet mixing is done until a mixture of uniform color and consistency are achieved which is then ready for casting. Before casting the specimens, workability of the mixes was found by compaction factor test.

IX. DEMOULD AND CURING OF THE SPECIMENS

The specimens are left in the moulds undisturbed at room temperature for about 24 hours after casting. The specimens are then removed from the moulds and immediately transferred to the different curing environment tubs i.e. cubes are cured in fresh water solution.



Fig. 1 Mixing & Compaction

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Fig. 2 After Casting



Fig. 3 Demould



Fig. 4 Curing

X. TESTS ON CONCRETE

A. Test on Fresh concrete

1) Standard Slump Test

The standard slump test is the most well- known and widely used test method to characterize the workability of fresh concrete. The inexpensive standard slump test which measures the consistency, is used on job sites to determine rapidly whether a concrete batch should be accepted or rejected.

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Table 7 Slump value

SI. No	Items	A
1	portion	1:1.58:2.55
2	Slump	75

XI. RESULTS AND DISCUSSION

A. Compressive Strength Test

The compression testing machine used for testing the cube specimens is of standard make. The capacity of the testing machine is 2000 KN. The machine has a facility to control the rate of loading with a control valve -The plates are cleaned and oil level is checked, and kept ready in all respects for testing. After the required period of curing, the cube specimens are removed from the curing tubs and cleaned to wipe off the surface water. It is placed on the machine such that the load is applied centrally. The smooth surfaces of the specimen are placed on the bearing surfaces, the top plate is bought in contact with the specimen by rotating the handle. The oil pressure valve is closed and the machine is switched on. A uniform rate of loading 140kg/sq.cm/min is maintained.



Fig. 5 Compression Testing Machine



Fig. 6 Compression Test (7 Days)

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Table 8 Compressive Strength Test (7Days)

Areca fiber Ratio (%)	Granite Powder (%)	Weight (Kg)	Strength (N/mm²)	Average
0	0	7.95 7.93 7.94	18.3 17.6 17.1	17.66
0.5	10	7.27 7.95 7.61	18.1 16.2 16.1	16.8
0.5	20	7.52 7.45 7.48	17.25 15.4 14.9	15.75
0.5	30	7.7 7.5 7.6	15.7 14.6 14.1	14.8

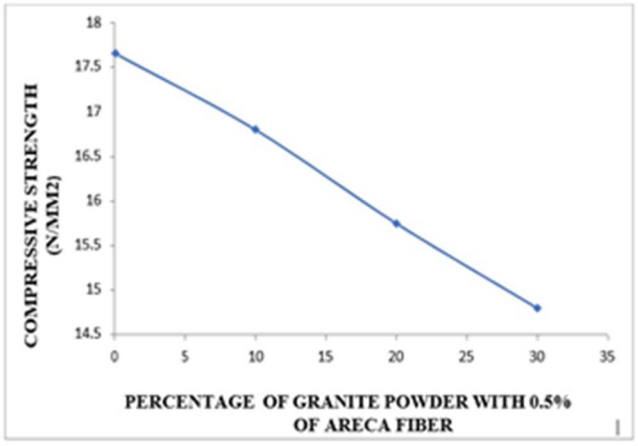
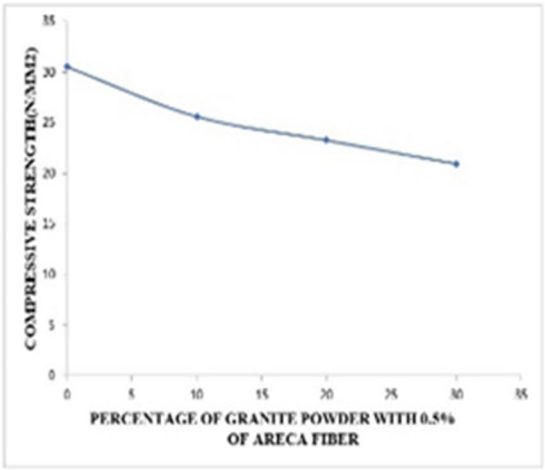




Fig 7: Compression Test (28 Days)

Table 9 Compressive Strength Test (28Days)

Areca fiber Ratio (%)	Granite Powder (%)	Weight (Kg)	Strength (N/mm²)	Average
0	0	7.90 7.95 7.23	27.30 33.60 33.40	30.5
0.5	10	7.30 7.48 7.39	25.60 24.90 26.30	25.6
0.5	20	7.34 7.36 7.35	22.30 24.60 22.90	23.26
0.5	30	7.67 7.62 7.64	21.30 20.90 20.60	20.93



B. Split Tensile Strength Test

EQUIPMENT

Compression testing machine, two packing strips of plywood 30 cm long and 12 mm wide, moulds, tamping bar (steel bar of 16 mm diameter, 60 cm long), trowel, glass or metal plate.

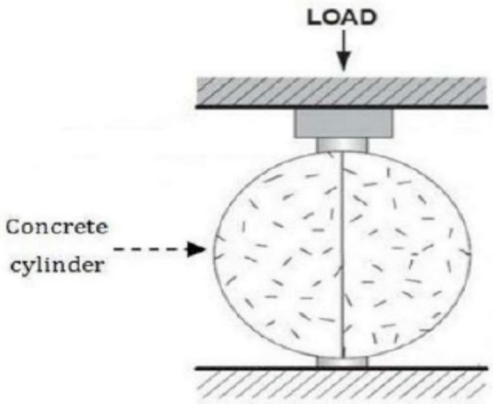


Fig. 8 Split Tensile Strength Test

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Table 9: Split Tensile Strength (7 Days).

Areca fiber ratio (%)	Granite Powder (%)	weight (kg)	Strength(N/MM2)	average
0	0	12.42 12.32 12.36	1.41 1.68 1.56	1.55
0.5	10	11.81 11.67 11.74	1.24 1.42 1.33	1.33
0.5	20	12.19 11.64 11.92	1.23 1.24 1.24	1.24
0.5	30	12.140 12.340 12.24	1.16 1.20 1.13	1.16

Fig. 9 Split Tensile Strength Test (7 days)

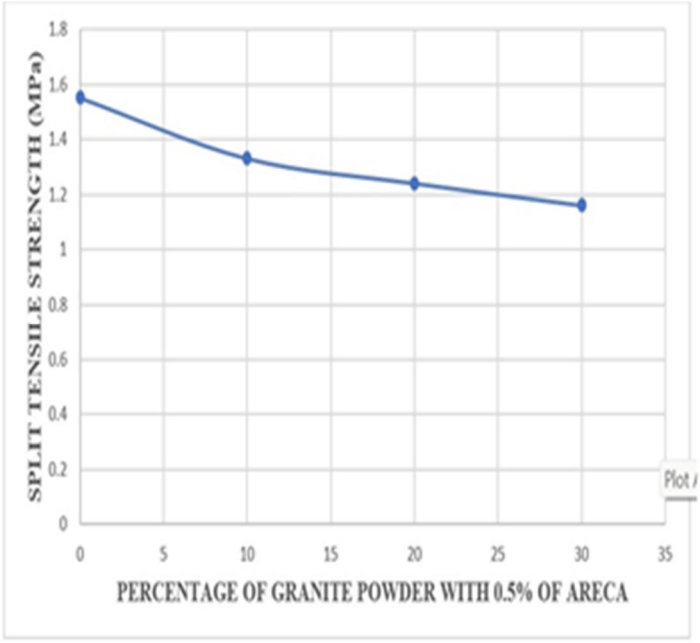
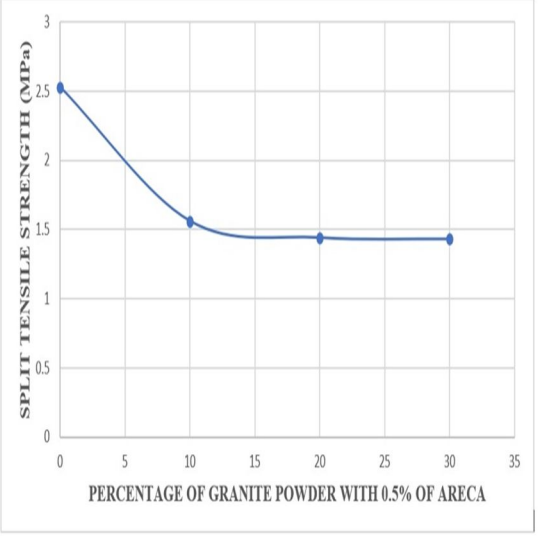




Fig. 10 Split Tensile Strength Test (28 days)

Table 10: Split Tensile Strength (28 Days).

Areca fiber ratio (%)	Granite Powder (%)	weight (kg)	Strength(N/MM2)	Average
0	0	12.40 12.34 12.37	2.94 2.12 2.53	2.53
0.5	10	11.45 11.72 11.59	1.68 1.44 1.56	1.56
0.5	20	11.94 11.61 11.78	1.41 1.48 1.45	1.44
0.5	30	12.20 12.23 12.22	1.34 1.48 1.48	1.43



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XII. CONCLUSION

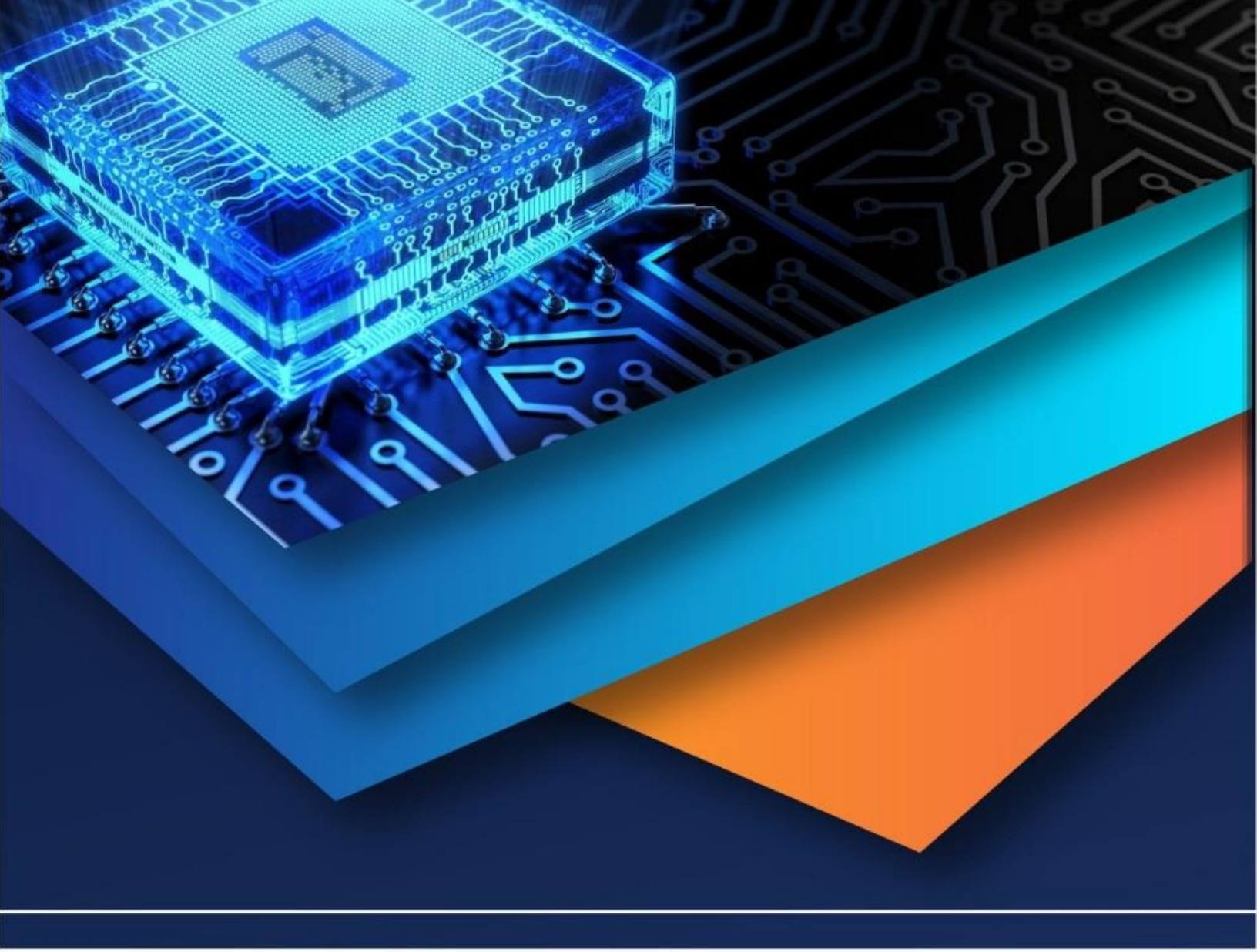
1) We observed that the Compressive Strength of concrete is achieved about 65% for 7 days of curing by replacing the cement of 10%, 20% & 30% by Granite Powder.
2) Here we used granite powder up to 30% instead of cement. Its main purpose is to control the use of cement. By adding waste granite powder to concrete the problem of waste disposal crisis can be reduced.
3) We have also noticed the strength of the concrete, where the split tensile strength is gradually decreasing and the compressive strength is gradually decreasing for 7 & 28 days of curing ages.
4) We made a project of incorporating Areca Fiber and Granite Powder into the concrete. One of the main reasons for using areca is because of its availability and is a raw material.
5) What we have noticed here is that the concrete workability drops here when we add the areca fiber.

A. *Further Stydy*

1) We might have either used the areca fiber in powder form instead of fiber form.
2) By varying areca fiber percentage might be increases the tensile strength of concrete results.
3) By using chemical admixture it will increases the workability of concrete.

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