PARTIAL REPLACEMENT OF COARSE AGGRGATE BY PLASTIC AGGREGATES AND CEMENT BY RICE HUSK ASH IN THE PREPARATION OF CONCRETE MOULDS

T. Shruthi[1], AKHILA.A[2], RAVALIKA D[3], SAI CHARAN V[4], SAI KUMAR T[5]

[1]Assistant Professor, [2]UG Scholar, [1,2]Department of Civil Engineering

[1,2]Kommuri Pratap Reddy Institute of Technology, Ghatkesar, Hyderabad, Telangana

ABSTRACT

Concrete is one of the significant materials of the construction industry. These days because of expansion in a population, the demand of infrastructure is expanding day by day. This prompts the increment in production of cement. In the present scenario the overall cement production is about 4.1 billion metric tons worldwide. This huge amount of production prompts utilization of natural resources and it is very unsafe for environment. Enormous amount of waste by-products are delivered from the manufacturing enterprises, for example, mineral slag, fly ash, silica fumes, rice husk ash and so on. the rice husk ash is an agricultural by-product which is obtained from the rice mills ,the husk which is obtained from mill is of no use i.e it is not even be used for animals to eat. Hence it is used as a fuel in various big industries the burning temperature is very high hence they are obtained from that the RHA is very lightweight. Plastic due to its properties such as durability, light weight and its ability to be moulded into any desired shape has enhanced its popularity. However, its excessive production has become a serious threat to the environment and the human health. Disposal of plastic wastes in the environment degrades land fertility, deteriorates aesthetic value of a place and threatens human health. Therefore, this project discusses on the method of reducing plastic wastes as well as safeguarding natural aggregates by incorporating it into concrete. It aims on finding the optimum percentage replacement of natural coarse aggregate with plastic coarse aggregate and cement with Rice husk ash (RHA) which can give the same or more strength compared to conventional concrete. This experiment revealed that 0% to 25% replacement of natural coarse aggregate with plastic aggregate and 5% replacement of cement with rice husk ash. Various experimental investigations are carried out to find out the compressive strength, split tensile strength and of concrete samples cured for periods. The results obtained from the experiments with satisfactory replacement of cement with rice husk ash and coarse aggregate with plastic aggregate are presented in this project report.

Key words: RHA (rice husk ash), plastic aggregate, compressive strength, split tensile strength.

1. INTRODUCTION

1.1 General

Today concrete has become an unavoidable construction material in the construction industry. Cement is the main ingredient in concrete and its production increases global warming by releasing huge amount of carbon dioxide into the atmosphere which is one of the main threats to the environment. To address this problem, Supplementary Cementitious Materials (SCMs) are used in concrete to reduce the use of high amount of cement content. SCMs such as Fly Ash, Rice Husk Ash, Ground Granulated Blast Furnace Slag, Silica Fume and Metakaolin play a vital role in concrete industry. It has not only economic and environmental benefits but also enhanced concrete properties. Since most of the SCMs are by-product materials of industrial and agricultural sectors, their utilization in concrete has become an efficient alternative to disposal of the same.

Construction industry is connected either logically or collaterally with the cement industry. The industry appears to be bright from projections based on current trends in population growth, and increasing urbanization and industrialization. However, this optimism must be tempered with changing attitudes in the society on ecological issues for example, the preservation and careful management of the environment and of natural resources, concerned with the ecological effects of altering the environment and the disposal of their by-products and the economy which has been always area of interest to all. Now a days, the material which is mostly used in the building construction is cement and it construct every structure in the world including highways, mansions, bridge works, and other structures. Globally, the largest segment of the concrete market is proposed to exceed $200 billion in revenue by 2017. In concrete mix, it plays the role of most significant, versatile and energy consuming material. Hence, the substitute of the cement with some secondary cementitious or cheaper material SCM can directly impact the cost of concrete. So, among SCM, the fly ash, which is the burnt residue, has been replaced with cement in various percentages.

During the hydration of Portland cement, Calcium Silicate Hydrate (C-S-H) and Calcium Hydroxide (Ca (OH)2) are produced. The C-S-H gives strength to concrete whereas Ca (OH)2 in hydrated cement paste gives a negative effect to concrete quality. It is an undesirable material which reduces the strength of concrete. When SCMs are added to the Portland cement concrete, the amorphous silica present in SCMs reacts with more of $Ca(OH)_2$ and converts them into C-S-H. This gives strength and reduces the permeability of concrete as well as improves the durability of the concrete. The addition of SCMs enhances the concrete properties due to pozzolanic effect and filler effect. Blending of SCMs in Portland cement concrete enhances the resultant concrete by making it stronger and more durable. Mineral admixtures have been incorporated into binary, ternary and quaternary concrete mixes (Shi et al. 2012). Many researchers prove that these materials improve the properties of blended cement concrete.

In this modern world aerated concrete is used as an innovative construction material. This aerated concrete is lightweight as compared to conventional concrete because of large number of voids present in it. The volume of pores present in concrete is 50% to 60% of the total volume of concrete. Size of these pores will affect the properties such as strength, durability, density, and water absorption etc. in concrete. Due to the pore space in concrete, it also provides good thermal insulation and acoustic insulation.

1.2 RHA

Effective use of Rice Husk Ash (RHA) a local additive which has been investigated to be super pozzolanic in a good proportion to reduce the high cost of structural concrete. Rice Husk Ash (RHA) is an agricultural waste product, and how to dispose of it is a problem to waste mangers. While Concrete today has assumed the position of the most widely used building material globally. The most expensive concrete material is the binder (cement) and if such important expensive material is partially replaced with more natural, local and affordable material like RHA will not only take care of waste management but will also reduce the problem of high cost of concrete and housing. There is an increasing importance to preserve the environment in the present-day world. RHA from the parboiling plants is posing serious environmental threat and ways are being thought of to dispose them. This material is actually a super pozzolan since it is rich in silica and has about 85% to 90% silica content. A "pozzolan" is therefore defined as "a siliceous or aluminium material, which itself possess little or no cementing property but will in a finely divided form and in the presence of moisture chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing Cementitious properties. A good way of utilizing this material is to use it for making "high performance concrete" which means high workability and very high early strengths, or consider high workability and long-term durability of the concrete. Recycling of waste components contribute for energy savings in cement production, for conservation of natural resources and for protection of the environment. Furthermore, the use of certain components with potentially pozzolanic reactivity can significantly improve the properties of concrete. One of the most suitable sources of pozzolanic material among agricultural waste components is rice husk, as it is available in larger quantities and contains a relatively large amount of silica. When rice husk is burnt, about 20% by weight of the husk is recovered as ash in which more than 75% by weight is silica. Unlike natural pozzolan, the ash is an annually renewable source of silica. It is worth to mention that the use of RHA in concrete may lead to the improved workability, the reduced heat evolution, the reduced permeability, and the increased strength at longer ages. In Iran, rice production has increased during these years, becoming the most important crop. Rice husk are residue produced in significant quantities.

1.3 Plastic Waste

Plastic needs no introduction as it is the widely used material now a days on our Earth. Due to its properties like strength, durability and easy processing it can be used for many purposes. Studies shows that plastic is nearly inert that is it get very less affected by the chemicals and have higher durability. Disposal of plastic waste is a huge problem as due to absence of organic compounds, it is non-decomposable material and proves to be a threat to our environment as it has many health hazards. As decomposition of plastic is a serious problem as it takes very long time and adversely affection the environment in many ways. So we can use it in construction, where we need life of structure to be improved and use of waste plastic after small processing can help us to reduce the waste in the environment which is new motto of civil engineering.a

With the drastic increase in the population, the use of plastics have also increased drastically. For years, researchers and environmentalists are looking for a solution to manage the plastic wastes disposal. Many ways of reusing plastics for were implemented, yet those ways were not enough to manage the amount of plastic wastes being generated. So incorporating plastic wastes in concrete can be another way to reduce the disposal problem of plastic wastes. It can not only reduce the waste disposal problem but also reduce the excessive extraction of natural aggregates. Excessive extraction of natural aggregates can cause silting and sedimentation in rivers and can also change river courses, causes death of aquatic life and expose land to agents of degradation. Since waste is abundantly available, concrete with plastic aggregates can be cheaper compared to conventional concrete.

Concrete is the most common building material and its popularity is due to its excellent characteristics such as durability and high strength. But use of concrete involves heavy environmental impacts such as change in animal habitats, high energy consumption and land degradation Concrete with plastic aggregate can be more economical than that with natural aggregates because of the low cost of wastes. The use of waste plastics in concrete avoids the need to obtain, produce or exploit natural aggregates from the environment while it gives a solution to plastic wastes disposal problem.

2. LITERATURE REVIEW

2.1 RHA

Saand et.al., (2019) studied the effect of partial replacement of cement with rice husk ash at different percentage i.e., 0%,2.5%,5%,7.5%,10%,12.5% and 15%. It was found that up to 10% replacement of cement with rice husk ash the compressive strength and split tensile strength will get increased but further increase in the percentage of rice husk ash beyond 10% the strength starts decreasing. The maximum value of compressive strength and split tensile strength for 10% of cement replacement with RHA obtained is 4.4MPa and 0.53MPa respectively.

Fabien et.al., (2019) have done experimental work on the replacement of sand with recycling waste perlite and pure perlite. Pure perlite sand and waste perlite sand (30% +30%), which is used to replace sand is characterised by low density, which makes the concrete expand under non-autoclaved condition. The presence of these waste products reduces mechanical strength but improve thermal insulation. It is found that increasing the cement by 2%, we can increase the mechanical strength by 21%. A 100% expended material with thermal conductivity of 0.176w/. k was obtained. Therefore, non-autoclaved swelling solutions have promoted the development of thermal insulation material based on recycled product.

Kunchariyakun et.al., (2018) had done an experimental investigation on replacement of sand with two agricultural waste i.e., rice husk ash and bagasse ash in preparation of AAC blocks. These samples are autoclaved at different autoclaving temperature (140oc, 160oc and 180oc) and different time period (4h, 8h and 12h). It was found that the effect of the increase in autoclaving temperature and time is directly related to the increase in strength and microstructural properties. But at 180oc it was found that there is no significant increase in strength with increase in time. The reason for no significant increase in strength is because Si ions from the sand reach its maximum dissolution.

Karolina R. And Muhammad F. (2017) concluded that fly ash and bottom ash can be used in the manufacturing of lightweight concrete to minimize the use of cement and sand. In normal NAAC lightweight concrete, the water absorption is found to be 5.66% which is greater absorption in the study and 2.76% is the smallest absorption by adding 30% fly ash in concrete. For normal NAAC the compressive strength is 8.891Mpa that is the lowest compressive strength in the study and the highest compressive strength is 12.687Mpa using fly ash. The researcher also concluded that the addition of 30% fly ash in concrete gives the highest tensile strength i.e., 1.540Mpa while NAAC gives the lowest tensile strength i.e., 0.801Mpa.

Wahane A. (2017) compared the AAC blocks with red bricks. The researcher concluded that these blocks are more earthquake resistant and safer than red bricks because of the lightweight of AAC blocks. Compared with red bricks, the weight of AAC blocks is almost reduced by about 80% which will lead to reducing a dead load of the structure. Also, it is found that these blocks have an attractive appearance and are easy to adapt to any style of building.

2.2 Plastic waste

Some of the literatures were explained the use of waste plastic in concrete like, concrete produced by mixing at partial replacement of plastic aggregates that is plastic waste aggregates are resulted from shredding (cut in to small pieces) used pet bottles and are of three types a,b,c based on their size and concrete produced by 7.5% replacement and 15% replacement to natural aggregates these 7.5% and 15% are replaced by three different types of plastic as categorized based on the shapes that is lamellar (Pc), irregular (Pf) and regular cylindrical granular (Pp) shaped aggregates are maintained nearer to target strength of concrete made by natural aggregates only. This research is about the study of curing conditions on the mechanical performance of concrete with the replacement of plastic aggregates to the natural aggregates.

To minimize the plastic waste in the environment another test conducted by the Fahed K Alqhatani and other three, the research work based on the plastic waste of the type manufactured by mixing 30% of recycled plastic and 70% of red dune sand filter, these two proportions mixed homogeneously and followed by compressing and heating the mix using compression molding press techniques to turn it in to solid sheets or slabs, which were used then manufactured plastic aggregates. Test conducted at a minimum slump of 100mm and a minimum compressive strength of 30MPa, replaced the plastic aggregates so obtained at a replacement level to 25, 50, 75 and 100%. This paper concludes slump values decreased by 11% to 23% (25mm-50mm) compared to light weight aggregates concrete with the increase in replacement level from 25 to 100%. The influence of replacement level on the fresh, hardened and microstructure properties of concrete was investigated. Here, compressive strength decreases with increase in replacement plastic aggregates.

Another study by F. Iucolano, B. Liguori D. Caputo, F. Colangelo, R. Cioffi on waste plastic to be utilized in concrete that is as a fine aggregates replacement. Tests conducted on the effect of recycled plastic aggregates on the Chemico-Physical and functional properties of manufactured hydraulic composite mortars. Tests have been conducted on density, porosity, compressive and flexural behavior and water vapor permeability. Here fine aggregates are the plastic waste, which has been manufactured at the industry and supplied with the standard fraction of particle size and with some chemical composition.

The PET bottles were shredded and then melted in the oven at a temperature of 280-320^{0}C. The molten plastic was then collected and cooled to get a solidified PET. Finally, it was crushed in the crushing machine and an angular aggregate with smooth surface was obtained. A volume replacement of 0%, 20%, 40% and 50% was taken for the experiment.

Faaeza Ahmed Abd Ul-Kareem concluded that Incinerating solid wastes is an efficient method compared with land filling to reduce the non-recyclable waste amount; the waste reduced by incineration is less than 30 % of original mass and the volume decrease is about 10 %. The pozzolanic activity of the mortars decreases as the percentage of solid ash used increases. However, with 5% and 10% replacement of cement by solid ash. The is aslight decrease in the initial and final setting times with an increase in the amount of replaced by solid west ash. Solid waste ash concretes showed significant reduction in drying shrinkage at all age compared to reference concrete. The concrete which has fly ash is an effective technique for the frost resistance. The high percent fly ash without any accompanied loss of concrete properties possible only when the fly ash is treated by using vitrification method. Where in such case there is arise additional costs suppressing the MSWI ashes utilization attractiveness for building industry. Solid waste ash concretes exhibit a slight improvement in workability relative to their reference concrete.

3. OBJECTIVE AND METHODOLOGY

3.1 Objective

The main objective of this research is to explore the possibility of using waste plastics as coarse aggregate and rice husk ash as cement in concrete preparation and to reduce the problems associated to plastic wastes and rice husk ash disposal.

Other objectives of the research are as follows:

- To obtain optimum percentage of aggregate replacement.
- Study on strength characteristics of M25 grade concrete with replacement of 5% cement by RHA and replacement of 0%, 5%, 10%, 15%, 20% and 25% coarse aggregate by plastic aggregates.
- To determine the fresh properties of concrete by slump cone test.
- To determine the harden properties of concrete by compressive and tensile strength test.

3.2 Methodology

(a) Methodology of Plastic aggregates preparation:

The methodology adopted for this study is given below:

1. Literature study was done on the available data on use of plastic in concrete.
2. Plastic was collected from the waste material.
3. Plastic was cleaned for the removal of any foreign material, dust etc.
4. It was then sundried for few hours and then melted in container.
5. The melted plastic was the drawn into sheets by pouring it on flat surface, and then allowed to cool down and get hard.
6. Cooled and hard plastic sheets were then broken into smaller particles by hammering the sheets.
7. Test related to properties of cement and aggregates were performed.
8. Proportion of plastic coarse aggregates (PCA) in different mixes was selected on the basis of available literature.
9. Mix design for different proportions of concrete was decided and tests were performed to obtain the mechanical properties of different mixes.
10. Based on the literature survey and optimum quantities of plastic, the following combinations were adopted.

(b) Methodology of Rice husk ash preparation:

Rice husk is incinerated manually up-to ash form. The final ash sieved with 75microns and used as partially replacement of cement.

(c) Preparation of concrete with RHA – Plastic aggregates

1. Initially find-out the physical properties of RHA, plastic aggregate, Cement, coarse aggregate and cement.
2. Find-out the M25 grade mix proportions as per IS10262-2019 and IS456-2000 code books.
3. Based on the mix design, the replacement of RHA and plastic aggregate find outed. The 5% of RHA by cement and varying percentages of Plastic aggregate (0% - 25%) by coarse aggregate in the preparation of concrete.
4. By Freshly prepared concrete, slump cone test will find out.
5. By Harden concrete, compressive and tensile strengths tests will find out.
6. Based on the test results optimum dosage of plastic aggregate replacement in concrete preparation.

4. EXPERIMENTAL WORK

4.1 Materials Used

- Cement
- Coarse Aggregates
- Fine aggregates
- Water
- Plastic aggregates
- Rice husk ash (RHA)

4.1.1 Materials and Testing

Table 4.4 Physical Properties of Fine aggregates & Coarse aggregates

Property	CA	FA
Water absorption	0.7%	0.3%
Specific gravity	2.67	2.55
Impact value	8%	-
Crushing value	14.21%	-

Table 4.5 Physical Properties of cement

Property	Result
Standard Consistency	34%
Initial Setting Time	41min
Final Setting Time	315min
Specific gravity	3.10

4.1.1.5 Water Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Water cement ratio used in the mix is 0.50.

4.1.1.6 Plastic Aggregates

The raw materials such as PET bottles and other plastics were collected from all the possible sites and then rinsed. Polymers such as polyethylene (PE), polystyrene (PS), polypropylene (PP), polyethylene terephthalate (PET) and high density polyethylene (HDPE) can be easily melted and cooled.

Table 4.6 Physical Properties of Plastic aggregates

Properties	Values
Water absorption	0.4
Specific gravity	1.295
Impact value	1.95%
Crushing value	2.35%

Fig. 4.12: Plastic aggregates

4.1.1.7 Rice husk ash

Rice husk is an agricultural residue widely available in major rice producing countries. The husk surrounds the paddy grain. During milling process of paddy grains about 78 % of weight is obtained as rice, broken rice and bran. Remaining 22 % of the weight of paddy is obtained as husk. This husk is used as fuel in the various mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the rest 25 % of the weight of this husk is converted into ash during the firing process, this Ash is known as rice husk ash. This RHA contains around 85 % - 90% amorphous silica. Rice husk is generated from the rice processing industries as a major agricultural by product in many parts of the world especially in developing countries. About 500 million tons of paddies are produced in the world annually after incineration only about 20% of rice husk is transformed to RHA. Still now there is no useful application of RHA and is usually dumped into water streams or as landfills causing environmental pollution of air, water and soil. RHA consists of non-crystalline silicon dioxide with high specific Surface area and high pozzolanic reactivity, thus due to growing environmental concern and the need to conserve energy and resources, utilization of industrial and biogenic waste as supplementary cementing material has become an integral part of concrete construction. Pozzolonas improve strength because they are smaller than the cement particles, and can pack in between the cement particles and provide a finer pore structure. RHA has two roles in concrete manufacture, as a substitute for Portland cement, reducing the cost of concrete in the production of low cost building blocks, and as an admixture in the production of high strength concrete.

Table 4.7 Chemical composition of RHA

Parameters	Experimental values(%)
Sio_2	2.36
Fe_2O_3	19.72
Al_2O_3	39.05
Cao	34.27
K_2O	0.06
MgO	1.02
Chloride	0.023
Loss Of Ignition	0.88

Table 4.7 Physical Properties of Rice husk ash

Property	Value

7

Specific gravity	1.096
Fineness value	4%

Fig. 4.13: Rice husk ash

4.2 Mix design

Table 4.8: Design proportions of materials for M25 grade concrete

Item name	**As per mixed Design (kg/m^3)**
Cement	438.13
Fine aggregates	612.58
Coarse aggregates	1109.27
water	197.16

4.2.1 Mix Proportions M25 grade of concrete is considered. Natural coarse aggregate is replaced with plastic aggregate with various percentages 0%, 5%, 10%, 15%, 20%, 25%. Cement is replaced with RHA by 5%. The mix design for concrete is carried out as per IS 10262-2019. Details of mix proportion for M25 concrete given below:

Volume of the cube = $1.1 \times (0.15)^3 = 3.7125 \times 10^{-3}$

Volume of the cylinder = $5.3014 \times 10^{-3} \times 1.1 = 5.83 \times 10^{-3}$

Table 4.9: Mix proportions for 1cube preparation

MIX	**RHA % - Plastic aggregate %**	**CEMENT (gm)**	**RHA(gm)**	**Coarse aggregate (gm)**	**Plastic aggregate (gm)**	**FA (gm)**	**Water (ml)**
M0	0 - 0	1626	0	4120	0	2270	732

M1	5 - 0	1544.7	81.3	4120	0		
M2	5 - 5			3914	206		
M3	5 - 10			3708	412		
M4	5 - 15			3502	618		
M5	5 - 20			3296	824		
M6	5 - 25			3090	1030		

Table 4.10: Mix proportions for 1cylinder preparation

MIX	RHA % - Plastic aggregate %	CEMENT (gm)	RHA(gm)	Coarse aggregate (gm)	Plastic aggregate (gm)	FA (gm)	Water (ml)
M0	0 - 0	2550	0	6460	0	3571	1.15
M1	5 - 0	2422.5	127.5	6460	0		
M2	5 - 5			6137	323		
M3	5 - 10			5814	646		
M4	5 - 15			5491	969		
M5	5 - 20			5168	1292		
M6	5 - 25			4845	1615		

4.3 Sample Production

Generally, the fresh and mechanical properties are the indicators of the performance of concrete. In the present experimental work, concrete is prepared with plastic aggregate by coarse aggregate in different proportions (0%, 5%, 10%, 15%, 20% and 25%) and cement by 5% RHA. Various specimens were cast according to standard provisions and cured. Various tests are conducted to determine:

ii) Slump cone test (workability)

ii) Compressive strength

iii) Split tensile strength

The mixing, casting and curing of the specimens and the experimental procedures of tests are explained in the following sub sections.

4.3.1 Mixing

All the required quantities of cement, fine aggregates and coarse aggregates weighed separately and mixed in dry condition. The obtained proportion of water is added to the composite mixture and mix thoroughly until a uniform mixture is formed. The same procedure is repeated for different mixes which includes the replacement of coarse aggregate with plastic aggregate and cement with RHA. After the concrete is mixed, the fresh concrete tests are to be carried out to measure the workability. The detailed explanation of the slump test is reported below.

4.3.2 Slump test

Slump cone test is most simple and common test conducted to determine the workability of concrete mix. According to the IS 1199-1959, Slump test is carried out for every batch of mix. The apparatus is shown in the Table 5.1 and Fig.5.2.

Table 4.11 Apparatus for slump test

S.No	Name of the apparatus	Size of the apparatus
1	Slump cone – Frustum	h = 30 cm, Bottom dia = 20 cm and top dia= 10 cm.
2	Tamping rod with one end round	16 mm dia and 60cm long

A sample of prepared concrete mix is taken for the test. The internal surface of the frustum of cone is cleaned and greased to avoid the adhesion of concrete. A non-porous base plate is placed on a uniform surface and the slump cone mould is fixed on it. Concrete mix is filled in three equal layers in the mould. The excess concrete is removed and levelled. Now, the cone is lifted in upward direction and the concrete slumps down. The slump (Vertical settlement) is measured in mm.

4.3.3 Casting and Curing

In the present work cubes and cylinder specimens were cast to conduct various tests.

4.3.3.1 Casting of cubes

Totally 63 cubes were cast for conducting various tests. Among them 63 cubes for compressive strength test. For the preparation of cube specimens, the mixed concrete is poured into the cube moulds made of steel of dimensions of 150 X 150 X 150mm. The moulds are cleaned and greased to avoid sticking of concrete to the moulds and tighten the bolts to prevent leakage of concrete. The concrete is put in layers into the moulds till the surface and levelled. The specimens are allowed to dry up for 24hrs.

4.3.3.2 Casting of cylinder

Total 21 number of cylinder specimens was cast for different tests. 21 cylinder specimens for split tensile strength test. The specimens are prepared by pouring the mixed concrete in the moulds of 150mm dia X 300mm height. The specimens are de-moulded after 24hrs.

4.3.4 Curing

The next stage is curing of the specimens. It is an important phase as the water for hydration is to be maintained in the specimens. Proper curing gives good strength to the concrete. So, after removing from the moulds the specimens are transferred to the curing tank containing water free from impurities and cured for 28 days.

4.4 Experimental Procedure

In this section, the test setup and experimental procedure for conducting various tests are discussed.

4.4.1 Compressive strength test (IS 516-1989)

Compressive strength of concrete is the most important characteristic and it is an indexing property as concrete is designed to carry compressive loads. This test is conducted to determine the variation of strength of the specimens with varying ratios of coarse aggregate and reduction in fine aggregate content. Compressive strength test machine (CTM) with 2000KN capacity is used to conduct the test on cubes. After placing the cube between the plates in the CTM, load is applied until the crack is observed on the specimen. The load at the point of cracking is considered as failure load and it is noted. The compressive strength is calculated by

Compressive Strength (σ) = Failure load / Cross sectional area of specimen

4.4.2 Split tensile Strength of Concrete (IS:516-1959)

The cylinder specimens were tested on compression testing machine to create a tensile cracking. Align the specimen so that the lines marked on the ends are vertical and cantered over the bottom plate. Apply the load continuously without shock at a rate of approximately 14-21 kg/cm^2/minute (Which corresponds to a total load of 9.9 ton/minute to 14.85 ton/minute).

Tensile strength = $2P / \pi L D$

Here; P = peak load

L = length of cylinder = 300mm

D = diameter of cylinder = 150mm

5. RESULTS AND DISCUSSIONS

As per experimental programme results for different experiments were obtained. They are shown in table format and graph format, which is to be presented in this chapter.

5.1 Fresh properties of concrete (Workability Test)

5.1.1 Slump Test

The Slump test was performed on the Rice husk ash – Plastic aggregate based concrete to check the workability of it at different replacements viz. 0 % - 0%, 5% - 0%, 5% - 10%, 5% - 15%, 5% - 20%, 5% - 25% and the following results were obtained, according to which it can be concluded that with the increase in % of Rice husk ash – Fly ash from M0 to M4, workability increases. The results obtained for Slump test are shown below in Table 5.1.

Table 5.1: Results of Slump test

MIX	RHA % - Plastic aggregate %	Slump (mm)
M0	0 - 0	120
M1	5 - 0	125
M2	5 - 5	128
M3	5 - 10	132
M4	5 - 15	135
M5	5 - 20	123
M6	5 - 25	110

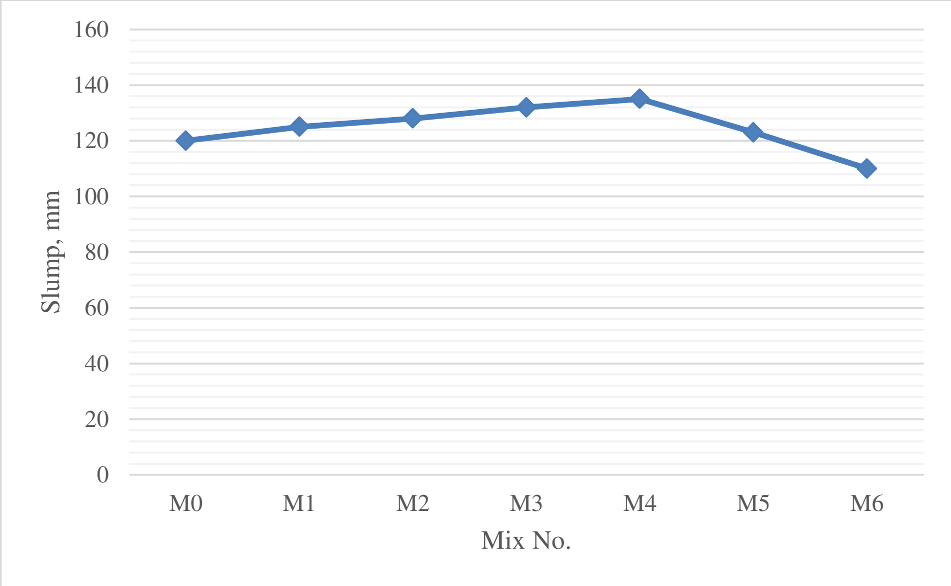

Fig 5.1 : Slump test results

The above figure 5.1 shows the slump results. It was observed that, the slumps increased from M0 to M4 mix with increased after that decreases in RHA –plastic aggregate based concrete. It was Medium Workability.

5.2 Harden properties of concrete

5.2.1 Compressive Strength Test

The compressive strength test was performed on the cubes of size 15 cm x 15 cm x 15 cm on the Rice husk ash – Plastic aggregate based concrete to check the compressive strength of it at different replacements viz. 0 % - 0%, 5% - 0%, 5% - 10%, 5% - 15%, 5% - 20%, 5% - 25% and the following results were obtained, according to which it can be concluded that with the increase in % of Rice husk ash – Fly ash from M0 to M4, compressive strength increases. The results obtained for Slump test are shown below in Table 5.2.

Table 5.2: Results of compressive strength test

MIX	RHA % - Plastic aggregate %	Compressive strength of cubes (N/mm^2)		
		7 days	14 days	28 days
M0	0 - 0	17.1	21.98	24.8
M1	5 - 0	18.98	23	26.3
M2	5 - 5	20	24.87	28.2
M3	5 - 10	21.2	25.1	28.9
M4	5 - 15	21.9	25.7	30.12
M5	5 - 20	19.6	22.6	28.1

M6	5 - 25	18.5	22	26

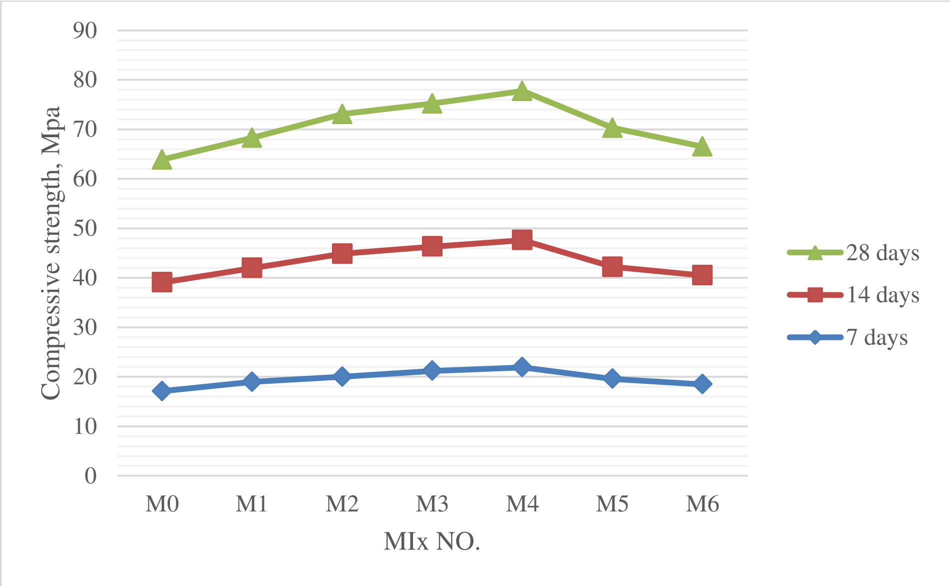

Fig 5.2: Compressive strength test result graph

The above figure 5.2 shows the compressive strength results. It was observed that, the compressive strength increased from M0 to M4 mix with increased after that decreases in RHA –plastic aggregate based concrete. The optimum dosage suggested from this study was (M4 mix) 5% RHA – 15% plastic aggregate.

5.2.2 Tensile Strength Test

The Tensile test was performed on the beams of size 300mm height x 150 diameter mm to check the Tensile strength of the concrete and the results obtained while performing the Tensile test on CTM are given in Table 5.3.

Table 5.3: Results of Tensile strength

MIX	RHA % - Plastic aggregate %	Tensile strength (N/mm^2)
M0	0 - 0	2.51
M1	5 - 0	2.67
M2	5 - 5	2.9
M3	5 - 10	2.93
M4	5 - 15	3.05
M5	5 - 20	2.87
M6	5 - 25	2.62

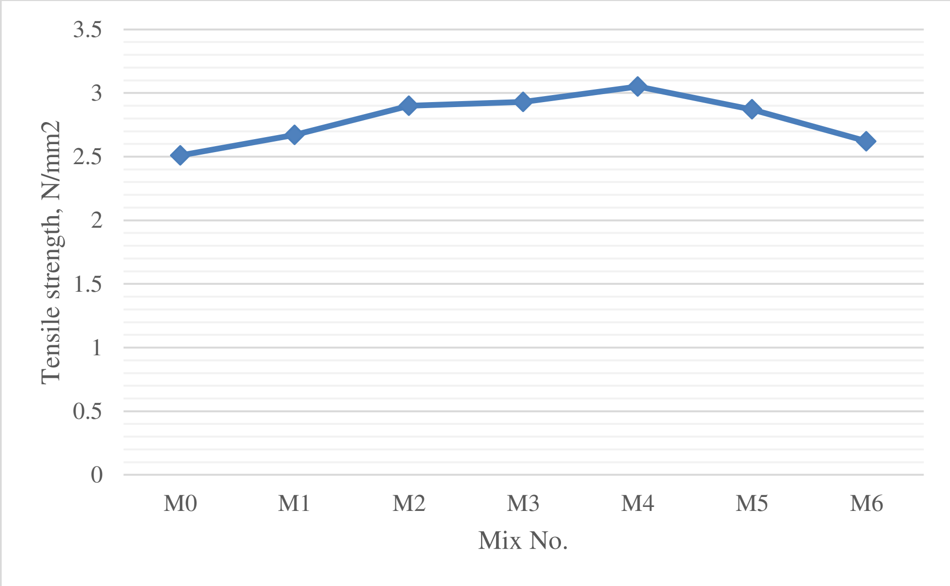

Fig 5.3: Tensile strength graph

The above figure 5.2 shows the tensile strength results. It was observed that, the tensile strength increased from M0 to M4 mix with increased after that decreases in RHA –plastic aggregate based concrete. The optimum dosage suggested from this study was (M4 mix) 5% RHA – 15% plastic aggregate.

5.3 Discussions

The workability was increasing with increasing up to M4 mix in RHA – plastic aggregate replacement in the concrete. The compressive and tensile strengths for RHA – plastic aggregate replacement in the concrete, was more than control mix. The strength increment percentages were mentioned below Table 5.4. The maximum or highest strength was gained for 5% RHA replacing with cement and 15% plastic aggregate replacing with coarse aggregate.

Table 5.4: Comparison of strengths

Mix	RHA % - Plastic aggregate %	28days compressive strength (Mpa)	Increment (%)	28days Tensile strength (Mpa)	Increment (%)
M0	0 – 0	24.8	-	2.51	-
M4	5 – 15	30.12	21.45	3.05	21.51
M6	5 -25	26	4.838	2.62	4.38

6.CONCLUSIONS

In this experimental investigation, the effect of rice husk ash and plastic aggregate blended in control concrete with respect to tensile behavior of the concrete cylinders and compressive behavior of the concrete cubes have been investigated. The experimental results have been compared with the control mix concrete. The following conclusions are drawn from the present experimental investigation.

1. Workability increases with increasing in the coarse aggregate by plastic aggregate replacement in the concrete up to 15% after that workability decreases.

2. The compressive and tensile strength highest gains for 5% rice husk ash by cement and 15% plastic aggregate by coarse aggregate replacement.
3. The maximum strength gained for 5% rice husk ash by cement and 15% plastic aggregate by coarse aggregate replacement in the preparation of concrete. The compressive and tensile strength increased by 21.45% and 21.51% as compare to the conventional concrete.
4. By replacing Supplementary Cementitious Materials (SCMs) such as rice husk ash and coarse aggregate by man-made plastic aggregate replacing to the concrete cost will be decreases and disposable problem of agricultural and industrial wastes reduces.

REFERENCES

1. Saand, A., Ali, T., Keerio, M.A. and Bangwar, D.K., 2019. Experimental Study on the Use of Rice Husk Ash as Partial Cement Replacement in Aerated Concrete. Engineering, Technology & Applied Science Research, 9(4), pp.4534- 4537
2. He, T., Xu, R., Da, Y., Yang, R., Chen, C. and Liu, Y., 2019. Experimental study of high-performance autoclaved aerated concrete produced with recycled wood fibre and rubber powder. Journal of Cleaner Production.
3. Sukmana, N.C., Khifdillah, M.I., Nurkholil, A.S. and Anggarini, U., 2019, April. Optimization of non-autoclaved aerated concrete using phosphogypsum of industrial waste based on the Taguchi method. In IOP Conference Series: Materials Science and Engineering,(Vol. 509, No. 1, p. 012095). IOP Publishing
4. Fabien, A., Sebaibi, N. and Boutouil, M., 2019. Effect of several parameters on non-autoclaved aerated concrete: use of recycling waste perlite. European Journal of Environmental and Civil Engineering, pp.1-18.
5. Kunchariyakun, K., Asavapisit, S. and Sinyoung, S., 2018. Influence of partial sand replacement by black rice husk ash and bagasse ash on properties of autoclaved aerated concrete under different temperatures and times. Construction and Building Materials, 173, pp.220-227.
6. Karolina, R. and Muhammad, F., 2018, February. The analysis of mechanical properties of non autoclaved aerated concrete with the substitution of fly ash and bottom ash. In IOP Conference Series: Materials Science and Engineering (Vol. 309, No. 1, p. 012133). IOP Publishing
7. Wahane, A.,2017. The manufacturing process of AAC block. International Journal of AdvancedResearch in Science and Engineering, 06, pp.4-11.
8. Shuisky, A., Stelmakh, S., Shcherban, E. and Torlina, E., 2017. Recipe-technological aspects of improving the properties of non-autoclaved aerated concrete. In MATEC Web of Conferences (Vol. 129, p. 05011). EDP Sciences.
9. Shrivastava, A., and Tiwari, A., Non-Autoclaved Aerated Concrete (NAAC) Blocks: An Alternative Building Construction Material.
10. Il'ina, L.V. and Rakov, M.A., 2016, January. Non-autoclaved aerated concrete with mineral additives. In AIP Conference Proceedings (Vol. 1698, No. 1, p. 070007). AIP Publishing.
11. Status of implementation of Plastic Waste Management (PWM) by Central Pollution Control Board (CPCB). Ministry of Environment & Forest. Government of India. November 2015.
12. State of the environment report 2003. "Waste Management". Karnata State Pollution Control Board. Page No 134-152.
13. Luís Ferreira, Jorge de Brito, Nabajyoti Saikia. "Influence of curing conditions on the mechanical performance of concrete containing recycled plastic aggregate". Construction and Building Materials, Elsevier 36 (2012) 196–204.
14. Fahad K. Alqahtani, Gurmel Ghataora, M. Iqbal Khan, Samir Dirar. "Novel lightweight concrete containing manufactured plastic aggregate". Construction and Building Materials, Elsevier 148 (2017) 386–397.
15. F.Iucolano, B.Liguori D.Caputo, F.Colangelo, R.Cioffi. Recycled plastic aggregate in mortars composition: "Effect on physical and mechanical properties". Materials and Design, Elsevier 52 (2013) 916– 922.

16. IS 10262-2009 “Guidelines for concrete mix design proportioning” Bureau of Indian Standards, New Delhi.
17. M.M. Rahman, M.A. Mahi2, T.U. Chowdhury. “Utilization of waste PET bottles as aggregate in masonry mortar” International Journal of Engineering Research & Technology, Vol. 2 Issue 11, November – 2013.
18. D. Foti. "Use of recycled waste pet bottles fibers for the reinforcement of concrete", Composite Structures, Elsevier, 2013, 96, pp. 396–404.
19. O. Y. Marzouk, R. M. Dheilly, and M. Queneudec. "Valorisation of post-consumer plastic waste in cementitious concrete composites", Waste Management, Elsevier, 2007, 27 pp. 310–8.
20. M. Bocci, S. Colagrande, and A. Montepara. "PVC and PET plastics taken from solid urban waste in bituminous concrete", Waste Materials in Construction Wascon 2000, Harrogate, England, pp. 186–195.
21. Faaeza Ahmed Abd Ul-Kareem, Utilization of Municipal SolidWaste Ash in Concrete by partial Replacement of Cement, https://www.iasj.net/iasj/download/58c91b7576a05708