DURABILITY PROPERTIES OF CONCRETE PRODUCED BY USING RHA AND WMP FIBRES

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Abstract- Growing urbanization around the world is leading to increased consumption of concrete, which poses serious environmental problems. The cement industry has very serious environmental issues and causes various sustainability issues; Carbon dioxide is a greenhouse gas that has many negative effects on the environment. An effective way to overcome this negative impact that the cement industry has on the environment is to use another material instead of cement in concrete. In this study, the aim is to use the rice husk ash produced from rice husk waste in large shredders in large quantities, and its disposal is also a major challenge for society and the environment. Rice husk ash is collected from tillers and converted to ash by manual combustion in barrels and used in the laboratory for research work. The cement in the concrete is partially replaced by rice husk ash, which also greatly reduces the consumption of cement and also utilizes the metal-plastic fiber waste in the concrete, as it is a non-biodegradable waste. Okay. To reduce non-biodegradable waste (WMP) used in concrete.

The purpose of this study was to partially replace cement in concrete with RHA and WMP and study the durability of mixed concrete and verify the variability of the results of ashless concrete samples and fiber. To achieve this, the cement is replaced by rice husk ash with three different variants i.e. 10%, 20% and 30% and three different variations of WMP fibres, i.e. - 0.5% , 0.75%, 1% and various endurance tests. conducted. including accelerated carbonation test, abrasion resistance test and chloride penetration test.

The results show that it can be safe to replace the cement up to 20% with rice husk ash and fiber taking into account the carbonation test. However, results obtained from chloride penetration test and abrasion resistance test show that rice husk ash can be used as a cement substitute up to 20%; beyond this limit, these results gave a slightly negative answer. Therefore, considering three tests, it is concluded that concrete mixed with rice husk ash replacing 20% is durable enough compared to normal concrete.

Key Words : Durability, RHA, WMP fibre, RCPT, Carbonation, Silver Nitrate ($AgNO_3$), Concrete

INTRODUCTION:

Durability is very important to have a sustainable concrete form. Today, with well-designed, community-based equipment, sustainable and modern production is needed. As we know, it is specifically the simplest, largest and most widely used building material in the world. Approximately 5 tons of concrete are produced according to the characteristics depending on the year. Having a concrete, future-oriented, maintainable generation is an important source of information. It far explains the ability of cement concrete to face weathering movements, chemical attacks and all the processes that can be put into the pot depending on the situation. Also, all forms of concrete that can maintain their original arrangement and ease of use in any environmental conditions are durable. The ultimate goal is to produce durable concrete at low cost. This method should start with checking the conditions of the environment and careers to which concrete may be exposed throughout manufacturing and equipment, and should select degradation mechanisms that should be overshadowed against the identity of these mechanisms. It may be uneconomical for concrete to provide safety against currently undisclosed environmental movements. Durability can be very important to have a durable concrete structure. Having a sustainable concrete structure for the future is the key. A durable concrete is a combination of appropriate power with least cementitious substances and most water-cementitious ratio (w/cm) so as to make concrete, are durable, it's far vital to deal both the direct and the indirect motives which could have an effect on the capacity of concrete to resist surroundings deterioration.

In this modern age, civil engineering structures have their very own structural and durability requirements, each shape has its personal supposed cause and hence to fulfill this cause, amendment in conventional cement concrete has turn out to be mandatory. it's been located that RHA and WMP FIBRES added in specific percent to concrete improves the mechanical homes, durability and serviceability of the shape. Concrete is a composite material composed particularly of water, aggregate and cement. regularly, additives and reinforcements are included inside the combination to gain the preferred physical homes of the finished material. When those components are combined together, they shape a fluid mass this is easily molded into any form.

Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. Concrete is one of the most versatile building materials. Concrete is one of the maximum flexible constructing substances. it is able to be solid to in shape in any structural form from normal rectangular beam or column to a cylindrical water garage tank, in a excessive-upward push building. it's miles effortlessly to be had in city areas at noticeably low value. The benefits in using concrete consist of high compressive energy, accurate hearth resistance, high water resistance, low protection, and long provider existence.

The disadvantages in using concrete include poor tensile power, and form-work requirement, pretty low strength according to unit weight. Tensile electricity of concrete is usually 8% to 15% of its compressive strength.

RHA and WMP FIBRE concrete is concrete containing fibrous material which will increase its structural integrity. It consists of short discrete fibres which might be uniformly dispensed and randomly orientated. Fibres encompass metal fibre, glass fibre, synthetic fibre, herbal fibre and waste metalized plastic – each of which lead various changes to the concrete. Further, the percent of fibre concrete changes with varying concretes, fibre materials, distribution, orientation and densities. Durability is one of the most important factors of concrete because of its fundamental incidence within the serviceability lifestyles of systems. In this admire, cracking performs a key role within the durability of concrete structures. Because of this truth it is vital to set up measures in order to hold the cracks under restrict that suggest a non- extensive hazard for the durability of structural factors. In this context, WMP fibres are supplied as a solution for this hassle, because due to WMP fibre mechanisms like the concrete ductility and post-cracking resistance can be drastically progressed.

even though a lot research has been executed to discover, investigate, and apprehend the mechanical trends of RHA and WMP FIBRES, little studies has targeting the transport the properties of this material, mainly permeability, may additionally affect the Durability and integrity of a structure. The boom in concrete permeability, due to the initiation and propagation of cracks, offers ingress of water, chlorides and different corrosive sellers, facilitating deterioration. it is widely said that WMP fibre corrosion is a whole lot much less intense as compared with regular concrete structures.

EXPERIMENTAL INVESTIGATION: It covers experimentation studies carried out to test the durability resistance of concrete with RHA and WMP by running various tests. Conducts carbonation test by casting a size (100 × 100 × 100) mm cube engaged in experimental research, performing abrasion resistance test by casting a size (70 × 70 × 70) mm cube, casting a height of 50 mm and a diameter of 100 mm. Chloride penetration test was performed. It describes the many kinds of materials used in this study and their properties, and describes methods for conducting experiments and subsequent testing steps. The various photos shown in addition to the concept have a clear idea of how.

Materials and Their Properties

The materials used to lay out the combination of M25 in this study were cement, best aggregate and coarse aggregate. Cement is partially replaced by rice husk ash and addition of waste metalized plastics and there are many possibilities. All materials used in the study and their properties and materials required for sample preparation are listed below.

Cement

The Ordinary Portland cement grade 43 used in this study & properties of Ordinary Portland cement grade are quoted in:

Fine aggregates

In accordance with IS:3831970, various tests have been carried out to find the properties of the sand required for the required application, such as sieve analysis, specific gravity, and particle size distribution.

Table 3.1 Properties of cement

S. No	Description	Values obtained	Requirement as per IS 1489 (part 1) 1991
1.	Specific gravity	3.11	3.0-3.15
2.	Consistency	33%	--------------

Table 3.2 fine aggregate properties

S. No	Property	Value obtained
1.	Specific gravity	2.63
2.	Fineness modulus	2.99
3.	Zone	II

Fine Sand Size Distribution

To know fineness modulus of the sand and classify it, a sieving analysis was carried out. Follow IS 383: 1970.The sample passes from different sieves 4.75mm, 2.36mm, 1.18mm, 600 microns, 300 microns, and 150 microns.

S.no	Sieve Size	Retained Mass in sieve (gm)	%age Retains in Sieve	%age Passes through Sieve	Accumulated %age retained in Sieve
1	4.75mm	48	2.4	97.6	2.4
2	2.36mm	262	13.1	84.5	15.5
3	1.18mm	528	26.4	58.1	41.9
4	600µm	266	13.3	44.8	55.2
5	300µm	648	32.4	12.4	87.6
6	150µm	184	9.2	3.2	96.8
7	Pan	64	3.2	-	------
					$\sum = 299.4$

Table 3.3 Sieve analysis for Fine aggregate

Coarse aggregates:- The crushing type of the aggregate is 10mm to 20mm.

Table 3.4 Properties of Coarse aggregate

Property	Values
Type	Crushed
Specific gravity	2.64
Fineness Modulus	7.56
Maximum size	20mm

Rice Husk Ash

Rice husk ash is a pozzolanic material which is used in cement and concrete gives advantages like improved strength, durability properties, reduced material costs due to cement savings and environmental benefits related to disposal of waste materials and reduced carbon dioxide and also reduced the environmental pollution.

- **Composition of rice husk ash**
  - RH is high in Ash content as compared to other biomass fuels ranging 14-25%.
  - Silica content in RHA varies from 83%- 98%.
  - Presence of high amount of silica makes it a valuable material for use in industrial applications.
  - Chemical composition of RHA determined by X-ray fluorescence (XRF) as :- SiO2 = 89%, CaO = 1%,

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Al_2O_3 = 1.20%, K_2O = 1.22 %, C = 18.24% Fe_2O_3 = 1.28%

Fig. 3.4 Rice Husk Ash

Table 3.5 Properties of Rice Husk Ash

Property	Value
Specific gravity	2.57
Appearance	Grey powder

Waste Metalized Plastics

- **Composition of WMP are:-**
  - Plastic Type = Low Density Polypropylene (LDPE)
  - Thickness = 0.07mm
  - SIZE (WxL) = 2x20 mm
  - Density = 915 – 945 kg/m3
  - Tensile Strength = 600 mpa
  - Elongation = 8-10%

Fig. 3.5 waste metalized plastics

Water

For the mixing of the concrete and the treatment, water is necessary.The water used for mixing and curing was followed per IS 456:2000.

Moulds

In this study, metal cube molds and cylindrical PVC molds have been used for casting samples. For the wear resistance test, a cube with the size (70 × 70 × 70) mm as in Figure 3.6 was prepared, and for the accelerated carbonization test, a cube with the size (100 × 100 × 100) mm as Figure 3.6 was used. For the chloride penetration test, prepare a cylinder shape mold a ht. of 50 mm and a dia. of 100 mm, as in Figure 3.6.

Fig. 3.6 Specimen

SAMPLES PREPARATION

Mix Design

For designed mix evaluation of M25 & performed according to procedures described in Indian Standard Code 10262: 2019. The proportions of the design mixture obtained after the experiment are listed in Table 3.6 below. The densities of the materials obtained as various alternatives for designing the mixture are listed in Table 3.7. In the operation of this experiment, a total of 90 samples of other shapes and sizes were formed to achieve the research objectives.

Table 3.6 Design proportion of M25 grade

Water cement ratio	Cement	Fine Aggregate	Coarse Aggregate
0.5	1	1.87	2.81

Table 3.7 Material density in use

Material	**Density (Kilogram per cubic meter)**			
Variations	**0% RHA & WMP**	**10% RHA & 0.5% , 0.75%, 1.0 % WMP**	**20% RHA & 0.5% , 0.75%, 1.0 % WMP**	**30% RHA & & 0.5% , 0.75%, 1.0 % WMP**
Cement	380	360	340	320
Fine Aggregates	713	713	713	713
Coarse Aggregates	1070	1070	1070	1070
Water	190	190	190	190
RICE HUSK ASH (RHA)	0	20	40	60
WASTE METALIZED PLASTICS (WMP)	0	1.26	1.86	2.49

Fig. 3.8 Formation of specimens

Fig. 3.9 Demolding specimens

Curing

The cube and cylinders samples were taken after 24 hours of cast sample and placed in water for 4 weeks as indicated, after a cure period of 24 hours.

Testing of Samples

Various testing of specific specimens for the durability of concrete when mixed with rice husk ash and the inclusion of waste metallized plastics have been carried out in this research. All tests were conducted according to the required requirements stated in the test code. The list of experimental experiments carried out, as detailed hereinafter:-

- Accelerated Carbonation depth Test
- Rapid Chloride Penetration Test
- Abrasion Resistance Test.

Accelerated Carbonation depth Test

Carbonization is the process in which carbon dioxide in atmosphere combines with concrete surface in the presence of moisture, causing the concrete to become carbonated or acidic. When this reaction occurs on the surface of concrete, it gradually penetrates deeper into the concrete, which is measured as the depth of carbonization. The response reached the reinforcement area, it will cause the iron to rust. The carbonation test was carried out in this study according to the criteria and procedures laid out in IS 1920-12. Following the forming of the specimens, place in the curing bin for 28 days before being placed in the lab for 14 days. Carbonation specimens were cubical in shape and measured (100 x 100 x 100) mm in length. Before placing the specimens in the carbonation chamber, the samples are sealed from four sides with epoxy or paraffin wax, as shown in fig 3.11. The temperature in the carbonation chamber should be in the range of (20±2) °C, the humidity should be in the range of 50±5%, and the carbon dioxide attention should be in the range of 4±0.5% by vol. in IS 1920-12. Specimens are stored in the machine for 28 days and are not covered with carbon dioxide. Extract samples after exposure Cut samples into

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pieces of 50 mm and cut phenolphthalein and spray on slices or parts. Next, carbonization strength is measured using five readings in common from all aspects.

Fig 3.13 According to the conditions specified in ISO 192012

After the exposure period is over, with the help of the cutter

shown in Figure 3.14 below, the sample is taken out and cut into 50 mm sections

.

Fig. 3.14 Concrete cutting machine and samples obtained after cutting

Rapid Chloride Penetration Test

The concrete structure is exposed to chloride ions present in the environment. Over time, chloride ions slow enter concrete and affect the strength of concrete components. The penetration of natural chloride ions is a laborious and gradual process. Therefore, in order to explore the impact of chloride ions on concrete for small time, a lab setting was created using the NT 492 structure, and we will draw conclusions about the chloride ions on the concrete. In this specimen with a dia. of 100mm & ht. of 50mm was cast. There is a rubber hose in model. The length of the hose is slightly shorter than model. The tube is tied in a glass bin containing the cathode fluid, and another one is filled with anode fluid. The cathode fluid using 10% by wt. NaCl about 2N water. The anolyte is prepared by dissolve 0.3N NaOH in deionized water, using a 30 V DC power supply The anode is tied to positive & cathode is tied to negative pole. As stated in the NT build 492, the samples were attached to power supply for a duration of 24 hours. Figures 3.15 and 3.16 show the relationship between the NT builds 492 set-up and the experimental setup prepared in the lab.

Fig 3.15 Migration Test Arrangements (NT BUILD 492)

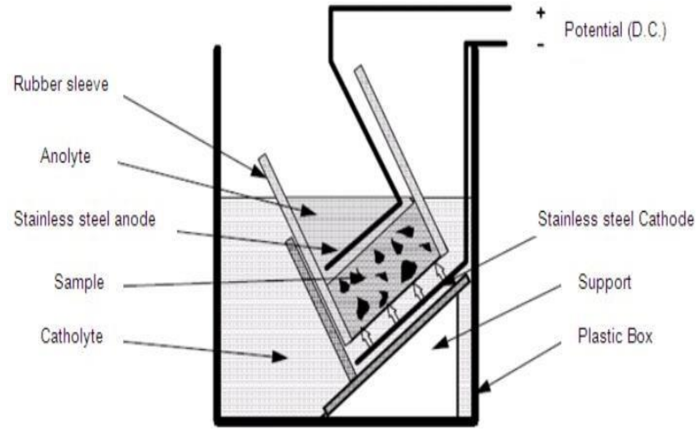
Fig. 3.16 Setup for the Experiment

After the 24-hour period has passed, the sample is removed and sliced vertically into two pieces using a concrete cuter, as fig. 3.17.

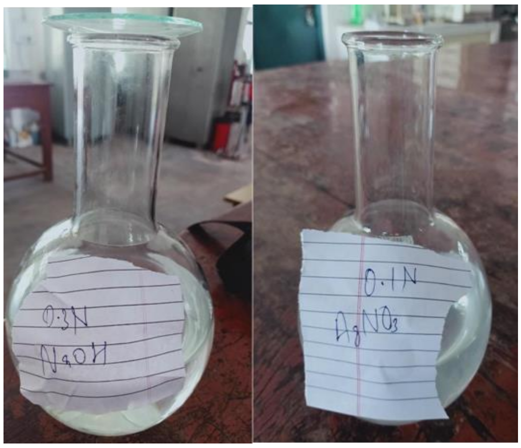
Fig. 3.17 Conc. cuter & specimen after cuting

Specimen is divided into 2 parts, depth of penetration of chloride ions can be assessed by used 0.1N silver nitrate fluid and then spraying this fluid on surface of cut sections. where spray, areas forms white or brown in shade. Free chlorides on the surface attaches the silver to make AgCl are white shade. Thus, white area will be the penetration intensity of the chloride ions and it can be measured using a caliper. The depth is determined by averaging six different parameters inside the location, and the average is used to determine the chloride intensity within the specimen.

Figure 3.18 depicts the NaOH and AgNO3



solutions



Abrasion resistant test

The abrasion resistant test is used to measure how well concrete resists wear. The purpose of this study is to compare the quality of concrete made with rice husk ash and waste metalized plastics to that of regular concrete. This test was carried out in accordance with IS 1237-2012. The abrasion resistance machine was used to test the resistance to abrasion. For this test, a sample with a cubical shape and a size of 70 x 70 x 70 mm was used.

Following curing, the samples were dried for 24 hours and then cleaned with sand paper or substance before being weighted. The sample is then placed in the abrasion machine's slot, which is rotated at a speed of 30 revolutions per minute. The spinning assembly of the machine receives an abrasive charge in the form of sand or abrasive powder. After 22 revolutions, the machine is stopped, sand is placed anew, and the process is repeated for at least 10 minutes on one sample. The sample's initial and final weights are recorded. Apparatus in Figure

Fig 3.20 Machine/Equipment for Abrasion

Fig 3.21 Abrasive Sample

The abrasive material size 1.18 mm and retaining it on a sieve with a size of 0.300mm..Figure 3.22 depicts the process of making abrasive material.

Fig. 3.22 Process of Abrasive Material

OUTCOMES AND CONSIDERATION: After multiple trials to complete this research, the results discovered are inclined to be shared here. The specific goal of the M25 grade analysis in order to prepare the usual mixture and afterwards cement within the concrete is partially replaced by rice husk ash with 10%, 20% and 30% and addition of waste metallized plastic fibres with 0.5%, 0.75% and 1.0%. Various durability evaluations of this mixed and ordinary cement were conducted and the impact of rice husk ash and wmp fibres on concrete durability was examined. The carbonation test, chloride penetration test, and abrasion resistance test were among the tests performed. After properly mixing the various materials in a tilting type mixer, the concrete is filled into the numerous moulds and placed on vibrating tables to remove air spaces and achieve adequate compaction. The cubes of size (100x100x100) mm are used for the carbonation test, and they are cured for 28 days. To conduct the chloride penetration test, a cylindrical pattern with a height of 50 mm and a diameter of 100 mm is cast and left to cure in the curing tank. Abrasion resistance testing was carried out using cubical samples of size

(70x70x70) mm that were cast and cured in a curing tank. For each of the three (3) percentage changes, three (3) samples were cast, with the average of the three results serving as the variant's final result, which was then compared to the reference concrete, which was free of rice husk ash and wmp fibres.

OUTCOMES OF CARBONATION TEST

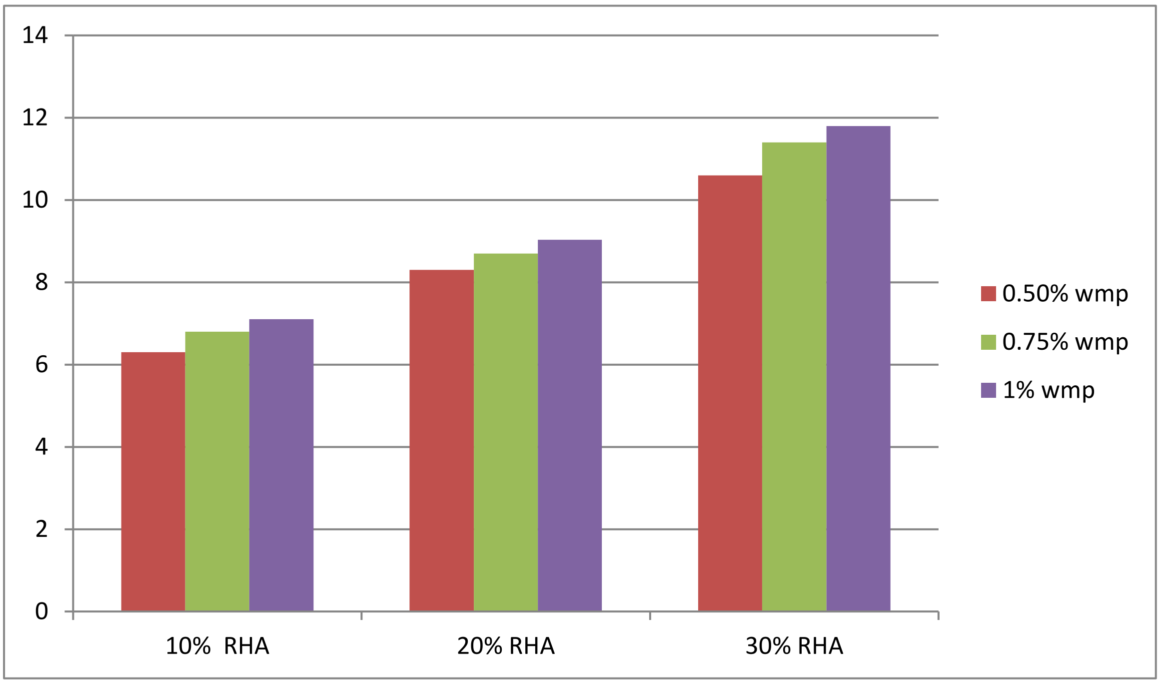
After curing, the (100x100x100) mm cubical samples were placed inside the carbonation machine and left for 28 days. After 28 days was over, the specimens removed from machine & split onto 2 halves for carbonization testing. The split portions had been wiped clean and dust-free, and the phenolphthalein fluid (1 percent

phenolphthalein in 70 percent ethyl alcohol) was sprayed on the cut samples to measure the carbonation depth and the samples were left for 90 mins on the surface of the samples, areas were identified, with the red pink zone confirming the non-carbonated zone and the colourless region indicating the carbonated zone. The carbonation intensity is measured with a vernier calliper with a precision of 0.04 mm.

with the growing amount of the RHA within concrete, When compared to normal concrete, the carbonation depth begins to decrease. This occurred because CO2 is extremely reactive with Ca(OH)2, and according to literature, rice husk ash has far less calcium hydroxide than cement. As a result, when cement is partially substituted with rice husk ash, the carbon dioxide impact is reduced when mixed concrete is exposed to it. When a result, as the amount of rice husk ash increases, the carbonation depths increase. It's perfectly acceptable to use rice husk ash with 1% wmp fibres to substitute cement up to 20%. However, according to literature, exceeding this limit would have disastrous consequences for the mechanical characteristics of concrete.

$$CaCO_3 + H_2O + Ca(OH)_2 + CO_2$$

When calcium hydroxide reacts with carbon dioxide to form insoluble calcium carbonate, the process is known as carbonation (CaCO3). Carbonation in concrete is caused by CaCO3, which results in a lesser pH value.



Different percentages of RHA & WMP

OUTCOMES OF RAPID CHLORIDE PENETRATION TEST

After the samples have been exposed to the electricity for 24 hours, they are removed and the chloride penetration depth is determined using the procedure described in Chapter 3. Specimens cleaned and broke transverse. The 0.1 N silver nitrate fluid is then spray over reduce portion, & 2

portions of the surfaces are shaped. The free chlorides bond to silver to form AgCl, resulting in a white spot on area. Intensity of the white area showing the penetrating force & measured with a caliper.

Fig 4.5 AgNO3 solution

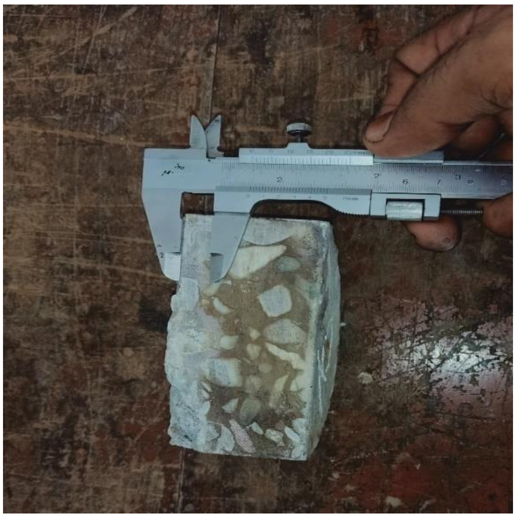


Fig. 4.6 Specimens

Fig 4.8 Chloride Penetration Depth

The results of the CPT utilising the migrated cell reveal that when cement is changed 20% RHA & addition 1% wmp fibres, chloride penetration intensity is equivalent to that of regular concrete. However, when more than 20% of the cement is substituted with rice husk ash, the chloride penetration depth increases somewhat. As a consequence of the findings, it has been established that rice husk ash may adequately substitute cement up to 20% in terms of chloride penetration intensity. In fig 4.9, the change in chloride penetration depth in different samples with different percents of rice husk ash and wmp fibres is graphically depicted.

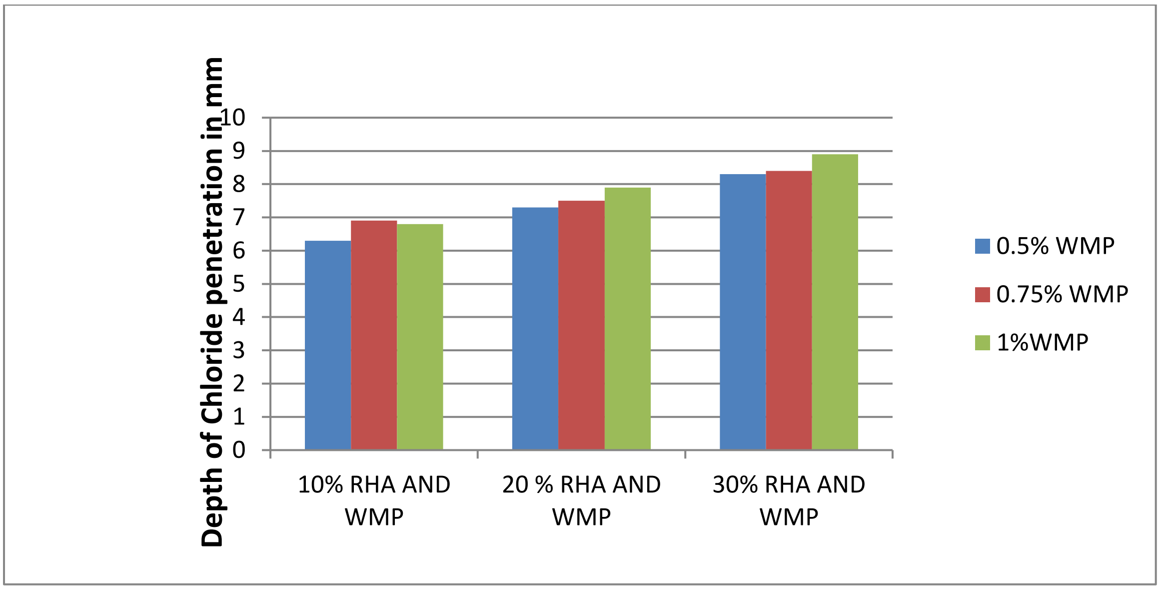


Fig. 4.9 Chloride depth changes as the proportion of rice husk ash and wmp fibres changes.

ABRASION RESISTANCE TEST OUTCOMES

ART performed to evaluate durability, and the technique described in Chapter 3 Test is carried out a variety of specimens with varying rice husk ash and wmp fibre replacement ratios. The % abrasion of the samples is calculated as the weight loss of the samples after they have been abraded.

According to the test findings, the percentage abrasion of the samples is equivalent up to a replacement ratio of 20%, but beyond that, the percentage abrasion begins to increase, and therefore the resistance to abrasion decreases. When we compare the percentage abrasion of the 10 percent, 20 percent, and 30 percent rice husk ash replacement results to the results of the 20 percent replacement, we find a 75

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percent rise in the percentage abrasion.

As a consequence of the findings, it has been determined that replacing up to 20% of the cement in concrete with RHA is safe.

FIGURE 4.10, percentage abrasion indicated by several samples with varied percentages of rice husk ash is graphically depicted.

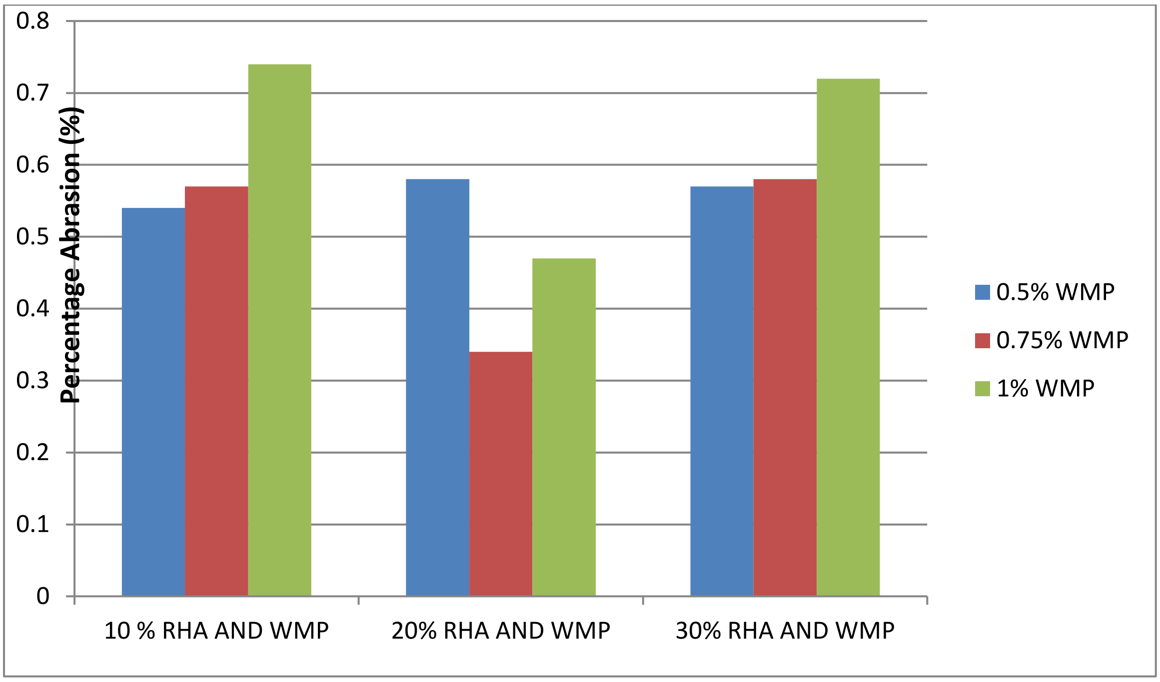

Fig 4.10 Abrasion percentages of several samples are compared.

CONCLUSIONS:

This research used an experimental study to explore the effect of partially substituting cement with rice husk ash and adding waste metalized plastics fibres on its durability qualities. In the previous chapter, the experimental programme of the research activity was presented; in this chapter, the conclusions that were noticed after completing different tests and from the findings acquired are explained. The following are a number of findings made from the test results of numerous tests conducted during the investigation.

The number of inferences made from the results obtained is defined as follows:

- Based on the results of the accelerated carbonation test, it was revealed that as the amount of rice husk ash in the concrete increases, the carbonation depth begins to decrease in comparison to regular concrete. This occurred because carbon dioxide reacts very well with Ca(OH)2, and, according to the literature review, rice husk ash contains far less calcium hydroxide than cement. As a result, when cement is partially replaced with rice husk ash, the carbon dioxide impact is also decreased. Combined concrete, on the other hand, is exposed to it. When a result, as the amount of rice husk ash increases, the carbonation depth decreases. According to carbonation effects, it's safe to update cement up to 20% with rice husk ash with 1% wmp, but according to literature review above this limit, it may have an unfavourable influence on mechanical characteristics of concrete.

- The effects of chloride penetration depth are equivalent to conventional concrete when using a migration cell and replacing up to 20% of the cement with rice husk ash with 1% wmp. However, when more than 20% of the cement is substituted with rice husk ash containing 1% wmp, the chloride penetration depth increases somewhat. As a consequence of the findings, it has been determined that rice husk ash and 1% wmp may be used to substitute cement up to 20% correctly while keeping CPT in mind.
- The conclusion of ART on concrete mix with rice husk ash and wmp fibres revealed % abrasion of specimens is similar to alternative variation of 20%, after that % abrasion starts to increase & the abrasion resistance is reduced. The proportion abrasion 10%, 20%, and 30% rice husk ash with addition of wmp fibres 0.5 percent, 0.75 percent, and 1 percent replacement and compare it to the 20% substitution results, we find that the percentage abrasion grows by 75 percent in a matter of seconds. As a consequence of the findings, it has been determined that replacing up to 20% of the cement in concrete with rice husk ash is safe.

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