Study on Composite Materials by Replacement of Ceramic Waste & Rice Husk Ash

Seetharam. P. G[1], ,
[1]Assistant Professor,
Department of Civil Engineering,
J.N.N Institute of Engineering,
Kannigaipair – 601102

Ram Kumar. T[2]
[2]Student,
Civil Engineering,
J.N.N Institute of Engineering,
Kannigaipair - 601102

Sarathi.J[3],
[3]Student,
Civil Engineering,
J.N.N Institute of Engineering,
Kannigaipair – 601102

Sachin. P. S[4]
[4]Student,
Civil Engineering,
J.N.N Institute of Engineering,
Kannigaipair - 601102

***Abstract* - The main focus of the study to strengthen the concrete with ceramic waste as coarse and fine aggregate and partially replacement of rice husk ash in cement .Due to increasing demand of construction material and degradation of environment, there is need to explore alternative construction materials from industrial as well as household waste and recyclable materials. Ceramic tiles are often damped as waste material after it becomes useless. But it can be recycled and used as a construction materials in present world. A large amount of carbon dioxide is released in the cement production. In the ceramic waste is replaced in concrete in an incremental order like 10%, 20%, 30%, 40% and 50% by weight of the materials in concrete for M25 grade. And the replacements are crushed ceramic as coarse aggregate. Ceramic power as fine aggregate and rice husk ash as partially replacement in cement and aim is low density concrete. In order to prove the following tests are conducted slump (workability) test, compressive strength test, Durability test (water absorption), Acid resistance test and flexural strength test.**

Keywords: Ceramic Waste, Rice husk ash, Eco-Friendly industrial waste, low cast, OPC cement, sustainable.

1.0 INTRODUCTION

In India ceramic production is 100 million ton per year. In the ceramic industry, about 15% - 30% waste material generated from the production. However this waste is not recycled in any form at present. The ceramic waste is durable, hard and highly resistant to biological, chemical and physical degradation forces. The ceramic industries are dumping the power in any nearby pit or vacant space, near their unit although notified areas have been marked for dumping. This leads to serious environment and dust pollution and occupation of vast area of land, especially after the power dries up so it is necessary to disposed the ceramic waste quickly and use in the construction industries. As the ceramic waste is piling up every day, there is a pressure on ceramic industries to find a solution for its disposal.

Rice husk is an agricultural residue which accounts for 20% of 649.7 million tons of rice produced annually. The produced partially burnt husk from the milling plants when used as a fuel also contribute to pollution and effect are being made to overcome this environment issue by utilizing this material as a supplementary cementing material. The chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop, climate and geological conditions.

RHA is not been utilized in the construction industry yet, the reason for that may be due to the lack of understanding of the RHA blended concrete characteristics.

The advancement of concrete technology can reduced the consumption of natural resources. They have forced to focus on recovery, reuse of natural resources and find other alternatives. The use of the replacement material often cost reduction, energy savings, arguably superior products, and fewer hazard in the environment.

1.1 Construction and Demolition Waste

C & D contribute the highest percentage of waste in worldwide. Furthermore, ceramic waste material, which include brick walls, ceramic tiles and all other ceramic products, contribute the highest percentage of waste within the C & D waste. The current option of disposal for this type of waste is landfill. Unavailability of standards, avoidance of risk, lack of knowledge and experience led to their being no active usage of construction material, the operating policy for disposal of the land- derived water containing waste to the marine environment.

1.2 Waste and Waste Management

Waste is defined as 'any matter whether gaseous, liquid or solid, or any combination, which from time to time may be proclaimed by the minister of Environment affairs and tourism by notice in the Gazette as an undesirable or superfluous by product, emission, discharge, excretion, or residue of any process or treatment. For instance of construction industries, C&D waste makes up significant percentage in many countries and apparent of clay bricks and ceramic industries have highest percentage of waste produced under the category of stony fraction.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

1.3 Ceramic waste classification

- Non- Recyclable waste is the waste except for the normal use as filling material.
- Recyclable waste such as recyclable construction and demolition (C&D) waste, ceramic waste have the potential to be used in concrete production. However, there are no guidelines and standards to the usage of these wastes in concrete.

In addition, the local construction industry does not have knowledge and experience to utilize the material.

1.4 Ceramic wastes properties

Ceramic waste have special properties, which can contribute positively in other areas of recycling. The research was conducted on the properties of ceramic waste forms to establish whether it was suitable to provide a stable geological formation, which can act as barrier to contain nuclear waste (radionuclides) for long periods. The main problem was the toxic radio isotopes with very long half-life of approximately 200 years. Due to the rise in environment awareness, there has been substantial amount of research in incorporating waste, especially C&D waste, into the making of concrete.

1.5 Other waste materials

Waste materials Ceramic wastes have special properties, which can contribute positively in other areas of recycling. The research was conducted on the properties of ceramic waste forms to establish whether it was suitable to provide a stable geological formation, which can act as barrier to contain nuclear waste (radionuclides) for long periods. The main problem was the toxic radio isotopes with very long half-life of approximately 200 years. Such as tires, rice husk ash, glass, and other waste have also been investigated on the potential of being in corporation in concrete production, as either partial or total substitute for aggregate of cement in concrete, and in some instances, to provide specialized mechanical or chemical characteristics to the concrete.

Recently other materials such as construction and demolition waste (ceramic), organic wastes (rice husk ash) have been introduced in the making of concrete, for both reason of environmental sustainability and improvement of concrete properties. However, ceramic wastes are not in common use in the making of concrete due to their Pozzolonic properties. They are also known for resistance to abrasion, low density, properties, which actually can be expected to improve the quality of concrete.

1.6 Ceramic Waste:

Ceramic waste material is hard, rigid. It is estimated that 15 to 30% waste are produced of total raw material used, and although a portion of this waste may be utilized on-site, such as for excavation pit refill. The Chemical composition of ceramic waste is

SiO_3 - 63.29%, Al_2O_3 - 18.29%, Fe_2O_3 - 4.32%, CaO - 4.46%, MgO - 0.72%, P_2O_5 - 0.16%, K_2O - 2.18%, Na_2O_3 - 0.75%, SO_3 - 0.1%, Cl - 0.005%, TiO_2- 0.61%, SrO_2 - 0.02%, Mn_2O_3 - 0.05%, L.O.I - 1.61%.
Density of ceramic = 2790 to 3070Kg/m^3.

1.7 Rice Husk Ash:

The husk was collected from paddy and it was then burned in the laboratory by using a Ferro-cement furnace. This furnace will hold up to 60 kg of rice husk, it has three opening through which fire is ignited. They too allow ventilation. A fire source was maintained under the furnace for around 10 minutes, after which the husks slowly burned for more than one day. The ash was left inside the furnace to cool down before it was collected.

The ash was ground for 90, 180, 270 and 360 minutes. The RHA ground for 90 minutes was only tested for particular size analysis and surface area to show the effect of grinding time on the average size of particle size and specific surface area. LOS angles (LA) Mill was used to grind the ash, this machine consists of a rotating drum with the opening on top of it, inside the drum there are 40 mild steel rods (10 mm diameter and 500 mm length) for grinding the ash. The mill can hold up to 5 kg of ash and this amount was kept constant each time the mill was used. The milling time was adjustable in the range of (90-360 minutes) according to the required fineness. And the chemical composition of RHA is determined by using x-ray fluorescence spectrometry (XRF).

Density of rice husk ash = 114 Kg/m^3.

1.1 Chemical and physical properties of OPC and RHA

Oxide composition (% by mass)	OPC	RHA
SiO_2	20.99	88.32
Al_2O_3	6.19	0.46
Fe_2O_3	3.86	0.67
CaO	65.96	0.67
MgO	0.22	0.44
Na_2O_3	0.17	0.12
K_2O	0.60	2.91
LOI	1.73	5.81
Specific gravity	2.94	2.11

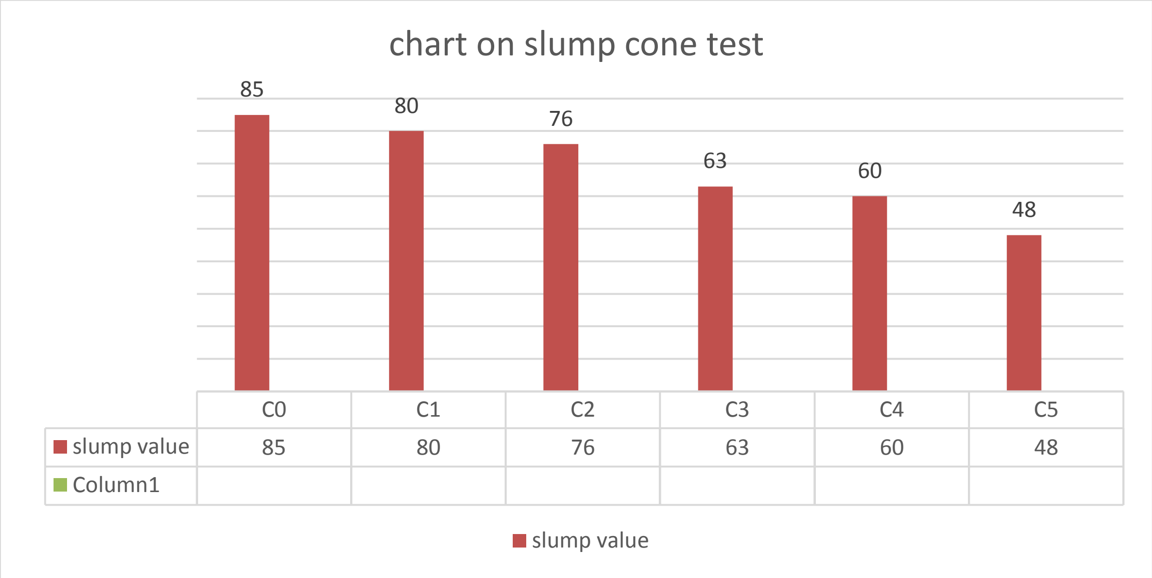
Experimental Study

Workability (Slump Cone - Fresh Concrete):

- The value of slump is decreased as increase in replacement level of RHA and ceramic waste
- It is absorbed that as increase in RHA the water absorption is also more and due to this it decreases in slump value

S.NO	SPECIMEN DESIGNATION	REPLACEMENT LEVEL (%)	SLUMP VALUE (mm)
1	C1	10	80
2	C2	20	76
3	C3	30	63
4	C4	40	60
5	C5	50	48

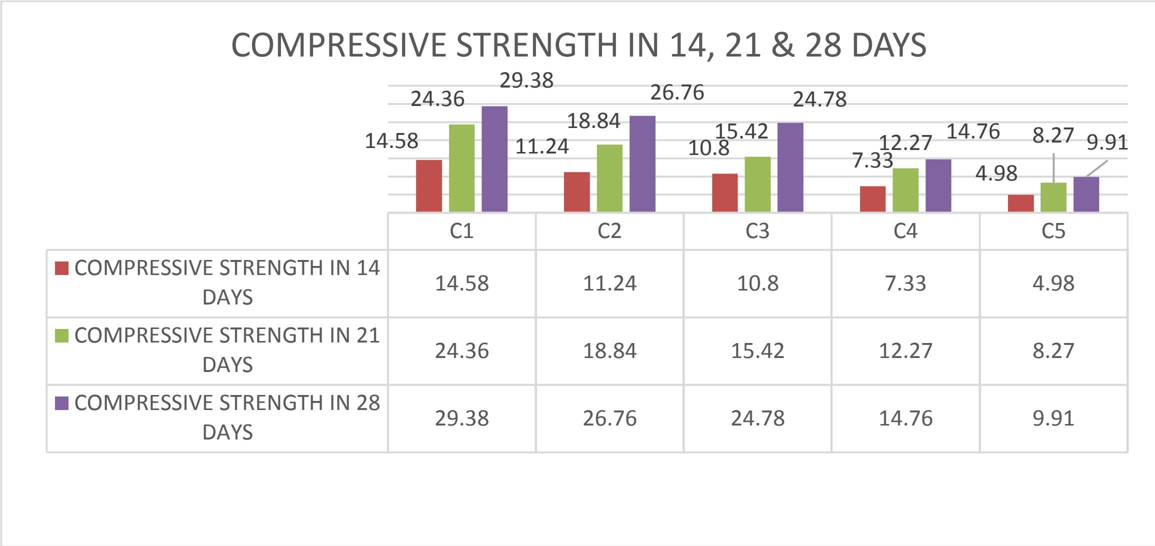
1.1 Slump value of workability



2.1 Compressive Strength Test:

Compressive strength is the most common test conducted on hardens concrete. It is very easy and simple to perform and partly because many of the desirable properties of concrete are qualitatively related to its compressive strength. The compressive test specimens are used: cube, cylinder and prisms.
Compressive strength = maximum load/area (P/A).

S.NO	SPECIMEN DESIGNATION	REPLACEMENT LEVEL (%)	COMPRESSIVE STRENGTH (M pa) days		
			14	21	28
1	C1	10	14.58	24.36	29.38
2	C2	20	11.24	18.84	26.76
3	C3	30	10.8	15.42	24.78
4	C4	40	7.33	12.27	14.76
5	C5	50	4.98	8.27	9.91



Combined Chart of Compressive Strength on 14, 21 And 28 Days.

As result in compressive strength the replacement of ceramic up to 20%-30% and whereas replacement of RHA up to 10%-20%.

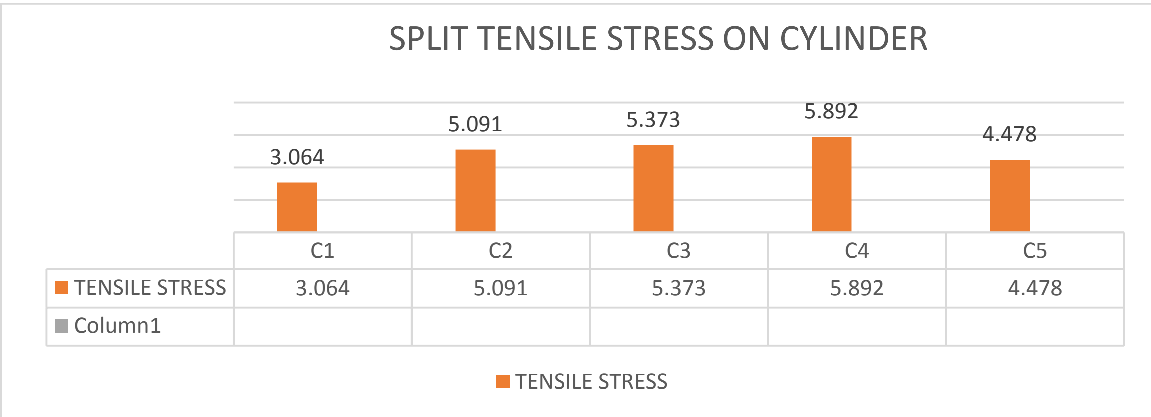
2.2 Spilt Tensile Test: Calculate the split tensile strength of the specimen as follows:

$$T = 2P / Pi\, l\, d$$

Where: T = splitting tensile strength, psi (KPa), P = maximum applied load indicated by the testing machine, lbf (kN), l = length, in. (m), and d = diameter, in. (m).

SPLIT TENSILE OF CONCRETE CYLINDER (300*150mm diameter):

TRAIL NO.	DATE OF CASTING	DATE OF TESTING	SPECIMEN DETAILS	ULTIMATE LOAD (KN)	TENSILE STRESS (N/mm2)
1	04.01.2017	03.02.2017	C1	216.67	3.064
2			C2	360.00	5.091
3			C3	380.00	5.373
4	05.01.2017		C4	416.67	5.892
5			C5	316.67	4.478



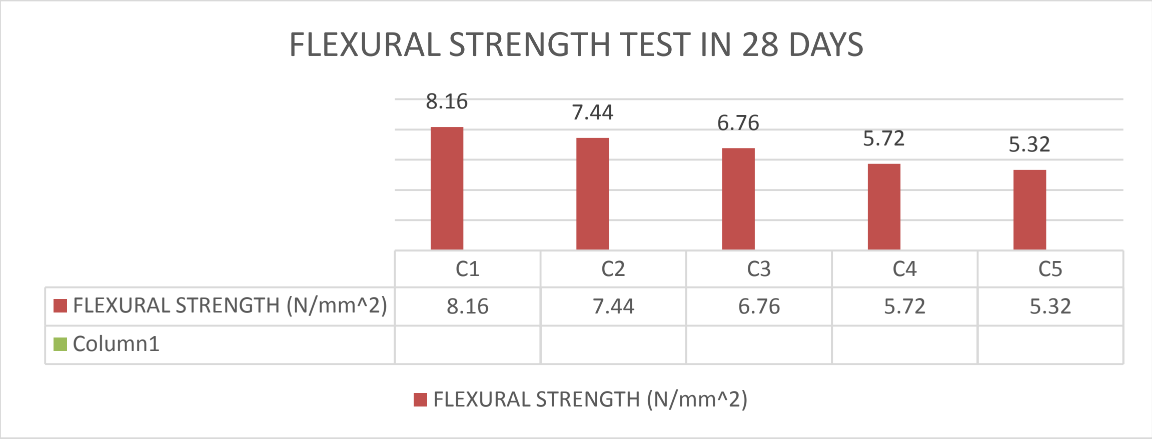
Split tensile stress on cylinder.

2.3 Flextural Strength Test on Prism: The normal tensile stress of concrete, when cracking occurs in a flexural test is given by modulus of ruptures, i.e. flexural strength. The standard test specimen is a prism of size 100*100*500 mm. The specimen should be cast and cured in the same manner as for casting of cubes. The specimens should be immediately tested on removal from the water. The flexural strength can be finding out by universal testing machine (UTM).The flexural strength can be found out by central loading as well as the load is applied through two similar roller mounted at third point of the supporting span. The flexural strength can be found out by formula as follows

$$F_{ct} = PL/ bd$$

S.NO	SPECIMEN DESIGNATION	REPLACEMENT LEVEL (%)	FRACTURE LOAD OF PRISM (28 DAYS)	FLEXURAL STENGTH (N/mm^2)
1	C1	10	20.4	8.16
2	C2	20	18.6	7.44
3	C3	30	16.9	6.76
4	C4	40	14.3	5.72
5	C5	50	13.3	5.32

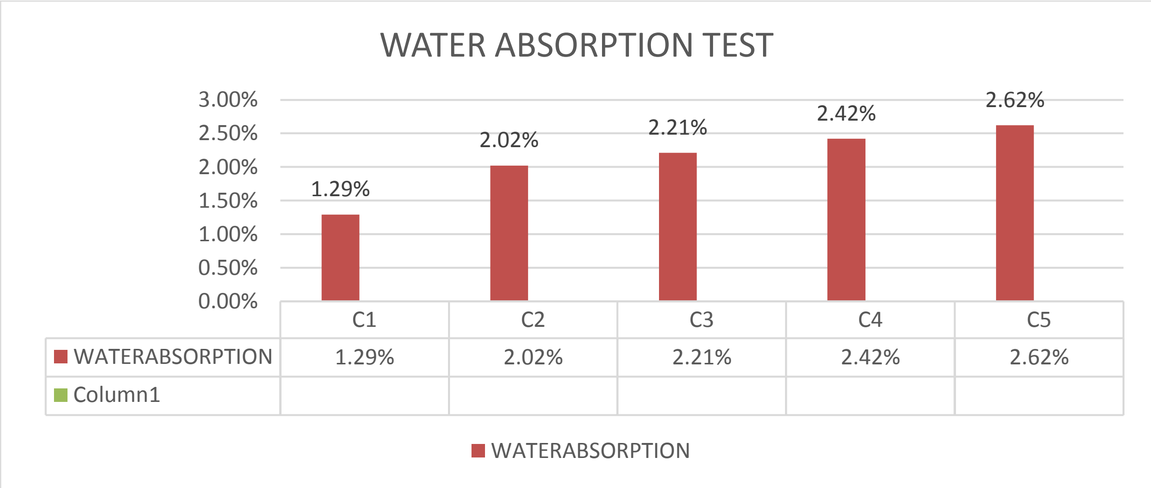
Flexural strength of prism in 28 days



Flexural Strength in 28 Days

2.4 Water Absorption Test: Water absorption test is carried out in harden concrete in which the Difference between dry weight before curing (w1) and dry weight after curing (w2), then the water absorbed is calculated as follows

SPECIMEN	REPLACE LEVEL	DRY WEIGHT BEFORE CURING (kg)	DRY WEIGHT AFTER CURING (kg)	WATER ABSORPTION (%)
C1	10 %	12.460	12.624	1.29 %
C2	20 %	12.432	12.686	2.02 %
C3	30 %	12.416	12.696	2.21 %
C4	40 %	12.423	12.732	2.42 %
C5	50 %	12.448	12.783	2.69 %



Water absorption on replacement of ceramic & RHA which result in water absorption upto 2%-3% of weight of specimen.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

2.5 Acid Resistane Test (Hcl In 0.1 Normality):

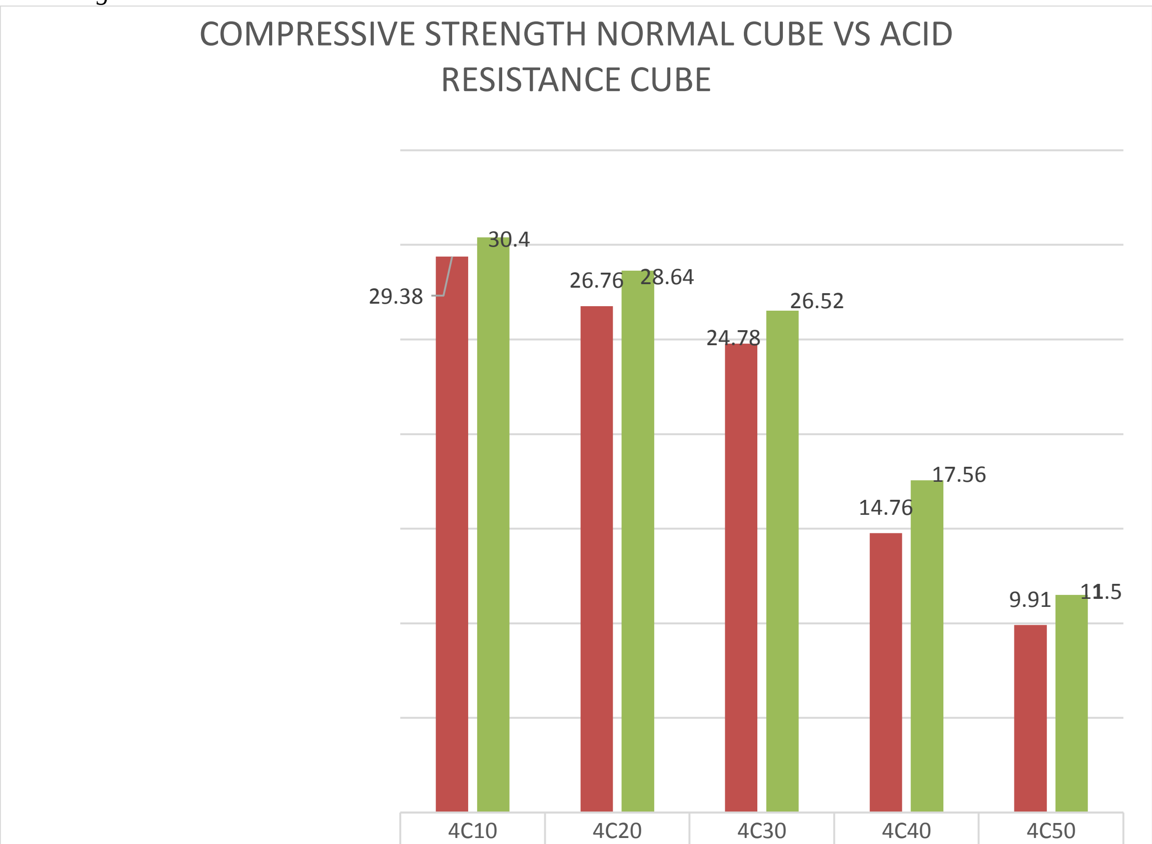
Acid attack is the most important aspects for consideration when we deal with durability of concrete. Acid attack particularly important because it is primarily cause of reinforcement. Statistic have indicated that over 40% of failure of structure is due to corrosion of reinforcement.

The cubes are cast and kept at a temperature of 270c and at relative humidity of about 90% for 24 hours. After 24 hours the cubes were removing from the mold and immersed in clean and fresh water until they were taken out for testing. After 28 days of curing. The cube were taken out, weighted accurately and were immersed in a 5% concentrated Sulphuric acid (H2SO4) & 5% of hydrochloric acid (HCL) for another 3days. After these days from the date of casting cubes are removed from acid curing and worst surface of cube were removed. The specimens were weighted again and the weight difference before and after acid curing was determined. After acid curing was determined. After that specimens were taken for compressive testing to measure their strength.

SPECIMEN	DRY WEIGHT BEFORE ACID CURING (W1)	DRY WEIGHT AFTER ACID CURING (W2)	ACID CURING IN (%) Reduce weight (W1-W2/W2)*100	COMPRESIVE STRENGTH 4TEST IN MPA 28DAYS + (3DAY ACID) CURING
C10	8.127	8.039	1.09%	30.4
C20	7.432	7.323	1.49%	28.64
C30	7.397	7.296	1.4%	26.52
C40	6.601	6.439	2.52%	17.56
C50	7.293	7.172	1.68%	11.5

Acid Resistance Test After Acid Curing.

Compressive Strength Test on Cube:



	4C10	4C20	4C30	4C40	4C50
COMPRESSIVE STRENGTH SUBJECTED TO NORMAL CURING	29.38	26.76	24.78	14.76	9.91
COMPRESSIVE STRENGTH SUBJECTED TO ACID CURING	30.4	28.64	26.52	17.56	11.5

3.0 CONCLUSION:

Economic point of view, fine and coarse aggregate contributes a bigger portion of costs in the production of concrete, thus to have them replaced by industrial waste, construction and demolition waste of ceramic tiles of similar characteristics is a major economic gain, while in sustainable development is a keywords improving living condition of the future generations. Thus recycling waste is only rational and logical step towards conservation of natural resources. By using ceramic waste as aggregate replacement and rice husk ash by cement replacement partially and they found to be performing better than normal concrete in properties such as density, durability, permeability, compressive and flexural strength. It's also found that strength not been affected when the specimen is subjected to acid test.

CERAMIC WASTE:

- It is observed that the compressive strength of concrete made using ceramic waste increase strength up to replacement of 40-50% and gain a good strength in 20-30%.
- In chloride environment ceramic waste shows better performance than conventional concrete.
- Ceramic waste replacement gives better strength and performance of concrete.

RICE HUSK ASH:

- It is observed that compressive strength of blended concrete with 10-20% replacement of RHA gives a good compressive strength.
- RHA increases up to 20% replacement without affecting the strength and workability of concrete.
- RHA fine powdered so that it enhances the blended of concrete better strength in replacement of cement.

REFERENCE

[1] C. Medina Martinez, M.I. Guerra Romero, J.M. Moran del Paso and Juan Valdes "Use of ceramic waste in structural concrete"(2009).
[2] F. Pacheco –Togal S. Jalali "Reusing of ceramic waste in concrete" 832- 838(2009).
[3] Zhang MH and Malhotra VM. High Performance concrete incorporation rice husk ash as a supplementary cementing material 629-632(1996).
[4] Raval A.D, Patral I.N, Pitroda J.K. (2013) "Use of ceramic powder as a partial replacement of aggregate".
[5] IS: 383-1970, Specification for coarse and fine aggregate from natural source of concrete, Bureau of Indian Standard, New Delhi.
[6] IS: 10262-2009, Guidelines for concrete mix design proportioning, Bureau of Indian Standard, New Delhi.
[7] IS: 9103-1999, concrete admixture – specification, Bureau of Indian Standard, New Delhi.
[8] IS: 516-1959, Method of Testing Strength of Concrete, Bureau of Indian Standard, New Delhi.
[9] MS. Shetty – "Concrete technology – Theory and practice" S. Chand and company, 2008.