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EFFECT OF RICE HUSK SILICA POWDER ON PROPERTIES OF CONCRETE

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Abstract ***Concrete has wide uses in structures, which makes it one of the most researched material of the 21st century. To meet the demand of the production of concrete, large quantity of Ordinary Portland Cement (OPC) is used as main binder material. Cement industry is believed to cause approximately 6% of global emissions of CO_2. As a result, environmental degradation and protection of natural resources are becoming very important issues to be taken care of to promote sustainability in the construction industries. Utilization of waste materials such as industrial and agricultural wastes in the concrete production eventually reduces the environmental impact. Additions of supplementary cementitious materials (SCMs) during manufacture or directly through cement replacement at the building site can reduce the cement use and ultimately reduces environmental damage. This experimental work carried out on concrete specimen containing Rice husk silica powder as partial replacement with portland pozzolana cement. Adding different dosage of Rice husk silica powder (5%, 10%, 15% and 20%) by weight of portland pozzolana cement. Indian Standard cube and cylinder are prepared to measure compressive strength after 14days, 28days, and 56 days and split tensile strength after 56days of curing and compare this strength with M25 conventional concrete.***

Keywords- Concrete, Micro-silica, Pozzolana, Portland pozzolana cement, Rice husk silica replacement

I. INTRODUCTION

Concrete is used daily for buildings, roads, bridges and dams. Concrete is formed by Portland cement, water, sand and gravel. Concrete has a long-life span and much less maintenance. Concrete can be molded in any form. Construction costs can be reduced by casting concrete in the workplace. Concrete is a fire safety material and can withstand high temperatures. Cement is a bonding material used to bind together fine aggregates and coarse aggregates. Water mixed with cement will give bond properties and workability, and usually gravel is used as coarse aggregate to make larger volume of concrete, and sand is generally used as fine aggregate. Its characteristic is to fill the gap between coarse aggregate and hard concrete through hydration. The paste is hardened to form a mass like a rock. Concrete is a very important artificial building material that is mass produced. Properly mixed and well hardened concrete is durable and can be used in a variety of applications. These qualities and the ability to shape in various shapes are made of very popular building materials and are used to build complex structures such as high-rise buildings, dams, highways, bridges, houses and sidewalks.

Concrete, as the most used material on earth, is known for its high compressive strength and low tensile strength.

The research about improving the concrete performance by using waste material and renewable resources is very popular as part of "green technology program". Over the past years, there has been an increasing number of papers on the use and utilization of industrial, agricultural and thermoelectric plants residue in the production of concrete. Different materials with pozzolanic properties such as fly ash, condensed silica fume, blast-furnace slag and rice husk ash have played an important part in the production of high performance concrete. During the late 20th century, there has been an increase in the consumption of mineral admixture by the cement and concrete is met by partial cement replacement Rice Husk Ash (RHA) is gaining its popularity to be used in concrete due to the silica content. Many researchers try to utilize the RHA as partial replacement of cement. The concept of environmentally friendly technology has inspired the researchers to do more in protecting the environment. Utilization of waste materials as alternative building materials has become the popular way to overcome the environmental problem in most developing countries. [1,3]

Substantial energy and cost savings can result when industrial by-products are used as a partial replacement for the energy intensive Portland cement. Among the different existing residues and by products, the possibility of using rice husk ash in the production of structural concrete is very important for India. India is the second largest rice paddy cultivating country in the world. Both the technical advantages offered by structural concrete containing rice husk silica and the social benefits related to the decrease in number of problems of ash disposal in the environment have simulated the development of research into the potentialities of this material. A large amount of agricultural waste was disposed in most of tropical countries especially in Asia for countries like India, Thailand, Philippine and Malaysia. If the waste cannot be disposed properly it will lead to social and environmental problem. Recycling of the disposed material is one method of treating the agricultural waste. The used of rice husk ash material in the formation of a composite material that can be used for construction. Rice husk ash is hazardous to environment if not dispose properly. [3]

Rice is considered one of the most important staples and is consumed by almost half the world's population. It will be necessary to increase rice production between 8 and 10 million ton s per year over the next decade to meet growing global demand. Rice husk (RH) is released during rice processing; due to its high caloric value (16720 kJ/kg) RH has great potential as a thermal energy source. Rice husk burning generates new waste, namely rice husk ash (RHA), which corresponds to 20% of husk volume. that ash contains high silica content (> 92%), making it a residue with high economic potential. This material has great applicability in industries including electronics, construction, chemicals and ceramics, among others. Several studies report the advantages of rice husk silica (RHS) addition to concrete matrices, including inhibition of the alkali-aggregate reaction due to the reduction of concrete permeability and decreased porosity of the matrix. These decreases lead to an increase in the concrete's compressive strength, as well as reduced carbon dioxide emissions to the atmosphere by the cement industries. [2]

II. MATERIALS

2.1 Rice husk silica

Rice husk is one of the agricultural waste, the outer covering of rice kernel is obtained by milling of paddy. About 200 kg of rice husk can be obtained from a tonne of paddy, constituting about one fifth of the total rice produced. Rice husk (RH) is released during rice processing. Because of its less nutritional value, it could not be used as animal feed, further the presence of siliceous composition shows unsuitable for natural degradation. One of the effective usage of rice husk as a fuel for boiler feed in order to produce steam. Here rice husk silica is produced from of residual rice husk ash by. hydrothermal process. [4]

Table.1 Chemical composition of Rice husk silica

Component (%)	Percentage
SiO_2	94.6
Al_2O_3	1.2
Fe_2O_3	0.9
CaO	0.6
LOI	2.7

Table.2 Physical properties of Rice husk silica

Parameter	Results
Specific surface area	1250 m^2/kg
Specific gravity	2.7

2.2 Aggregate

Generally, locally available coarse aggregate with combination of 20mm (65%) and 10mm (35%) are used in the present work. Also, natural available river sand of Zone II is used as a fine aggregate.

III. MIX DESIGN AND MIX PROPORTION

Mix design for concrete grade of M-25 has been carried out as per IS-10262:2009 and mix proportion shown in table.

Table.3 Mix proportion for mixes

No.	Cement (PPC) (kg)	Cement (OPC) (kg)	Rice husk silica (%)	Rice husk silica (kg)	Fine aggregate (kg)	Kapachi (kg)	Grit (kg)	Water (kg)
Mix-1	394.64	0	0	0	674.2	752.64	405.27	197.32
Mix-2	0	394.64	0	0	674.2	752.64	405.27	197.32
Mix-3	374.908	0	5	19.732	674.2	752.64	405.27	197.32
Mix-4	355.176	0	10	39.464	674.2	752.64	405.27	197.32
Mix-5	335.444	0	15	59.196	674.2	752.64	405.27	197.32
Mix-6	315.712	0	20	78.928	674.2	752.64	405.27	197.32

IV. EXPERIMENTAL STUDY AND TEST RESULTS

For compressive strength test, cube specimens of dimensions 150mm x 150mm x150 mm were casted, then cubes are placed in water for curing after 24 hours of casting. The cubes are tested for compressive strength on compressive testing machine after 14day, 28day and 56day. For split tensile test, cylinder specimens of dimeter and height 150mm x 300 mm are casted, then cylinder are placed in water for curing after 24 hours of casting. The cylinder is tested for split tensile strength after 56day.

Table 4. Test results: Compressive strength(Cube-Cylinder)

Mix	Compressive strength-Cube (N/mm^2)			Compressive strength-Cylinder(N/mm^2)		
	14 Days	28 Days	56 Days	14 Days	28 Days	56 Days
M25 (PPC)	25.65	31.76	33.23	21.97	26.39	28.45
M25(OPC)	25.5	31.83	32.1	21.88	26.16	27.23
Mix-3	26.42	32.49	34.19	22.46	26.76	28.79
Mix-4	28.53	34.18	36.62	24.15	27.81	31.13
Mix-5	31.58	37.13	39.48	27.16	32.37	33.78
Mix-6	30.1	34.79	36.59	26.22	29.57	31.40

Table 5. Test results: Ratio of Cube-Cylinder (Compressive strength) and Split tensile strength

Mix	Ratio of Cube-Cylinder (Compressive strength)			Split tensile strength (N/mm^2)
	14 Days	28 Days	56 Days	56 Days
M25 (PPC)	0.857	0.831	0.856	3.34
M25(OPC)	0.858	0.822	0.848	3.3
Mix-3	0.850	0.824	0.842	3.56
Mix-4	0.846	0.814	0.850	3.74
Mix-5	0.860	0.872	0.856	4.03
Mix-6	0.871	0.850	0.858	3.66

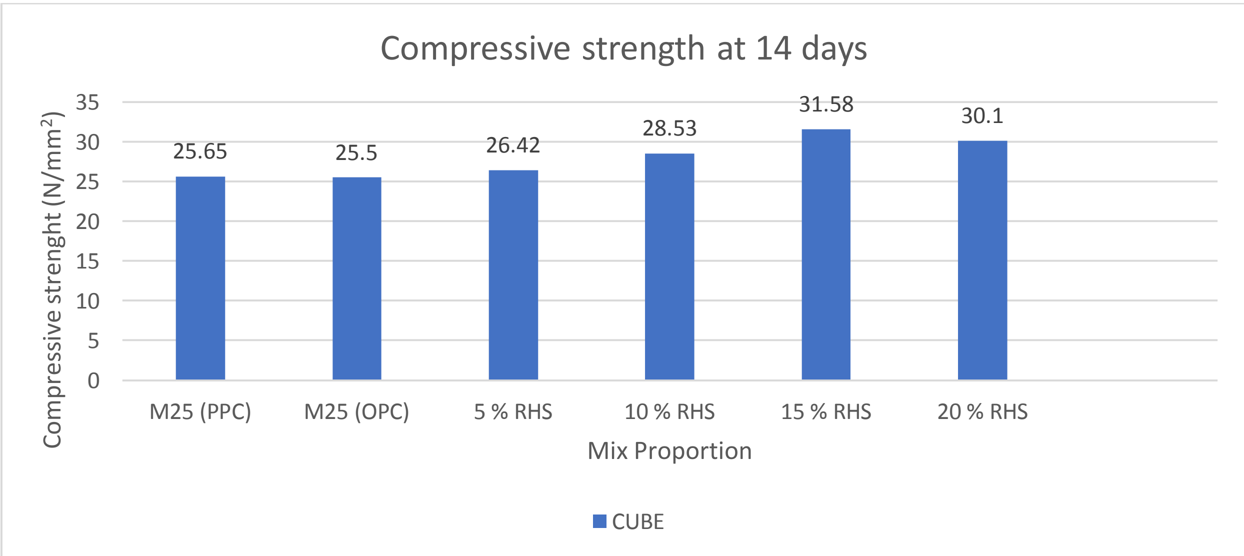

Chart-1 14day compressive strength (Cube)

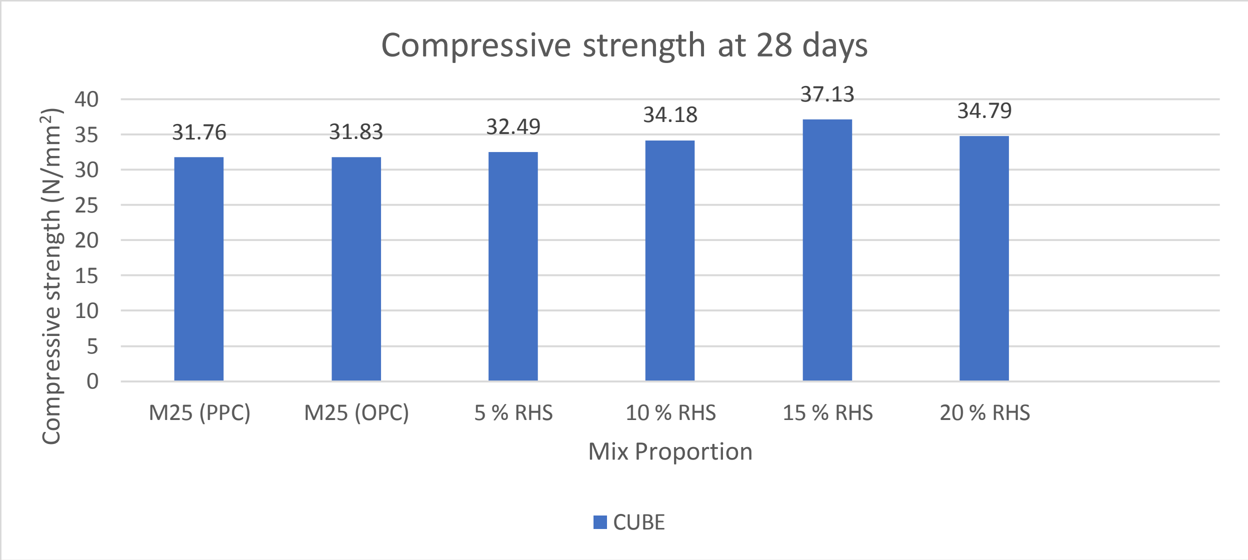

Chart-2 28day compressive strength (Cube)

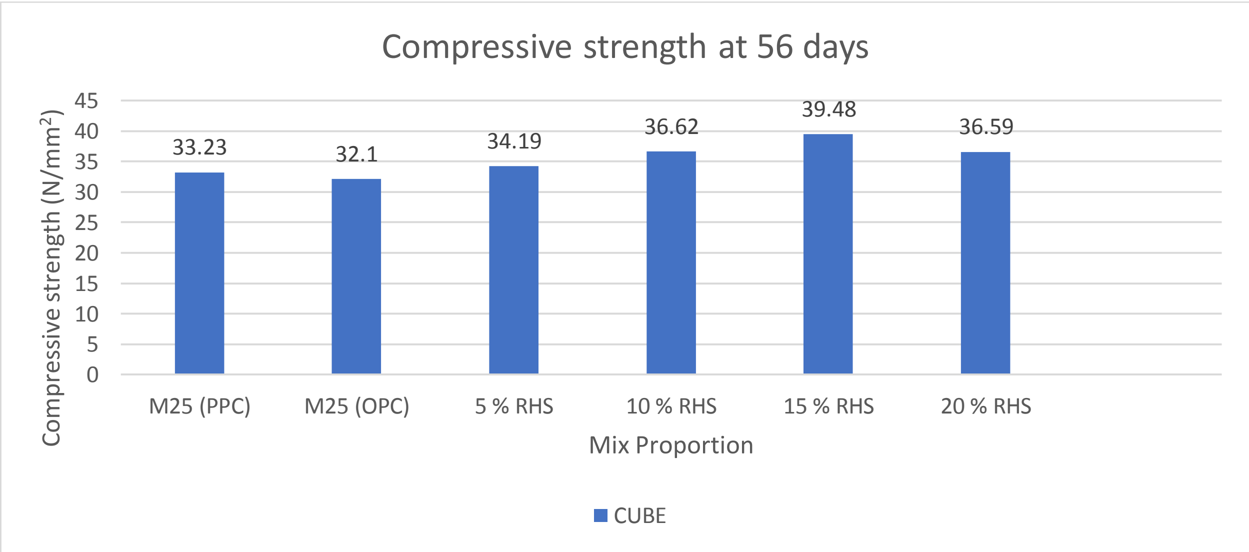

Chart-3 56day compressive strength (Cube)

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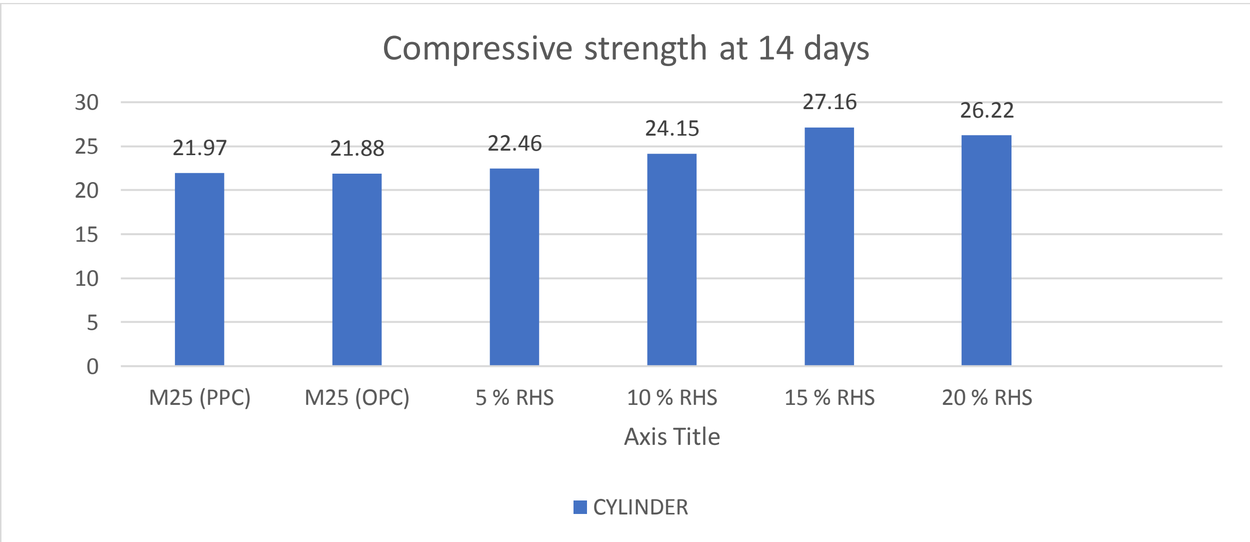

Chart-4 14day Compressive strength(Cylinder)

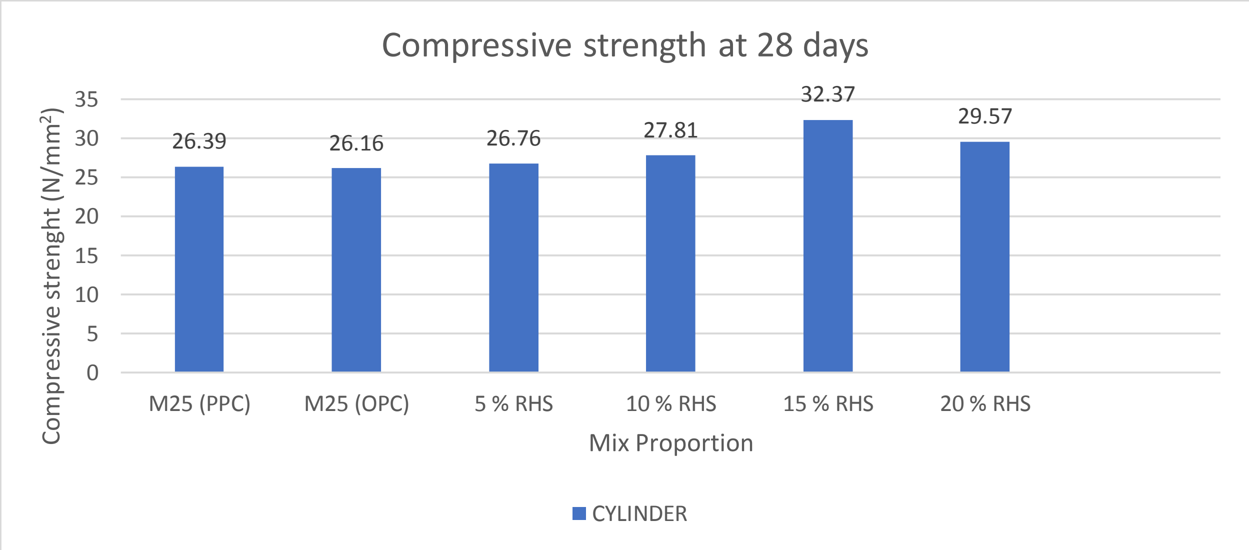

Chart-5 28day compressive strength(Cylinder)

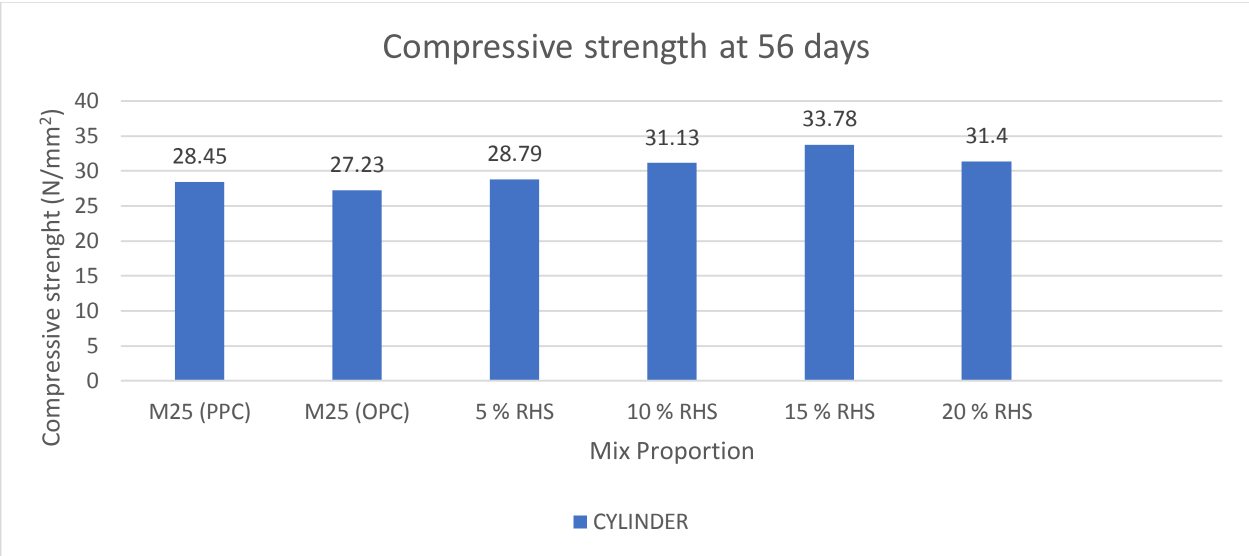

Chart-6 56day compressive strength(Cylinder)

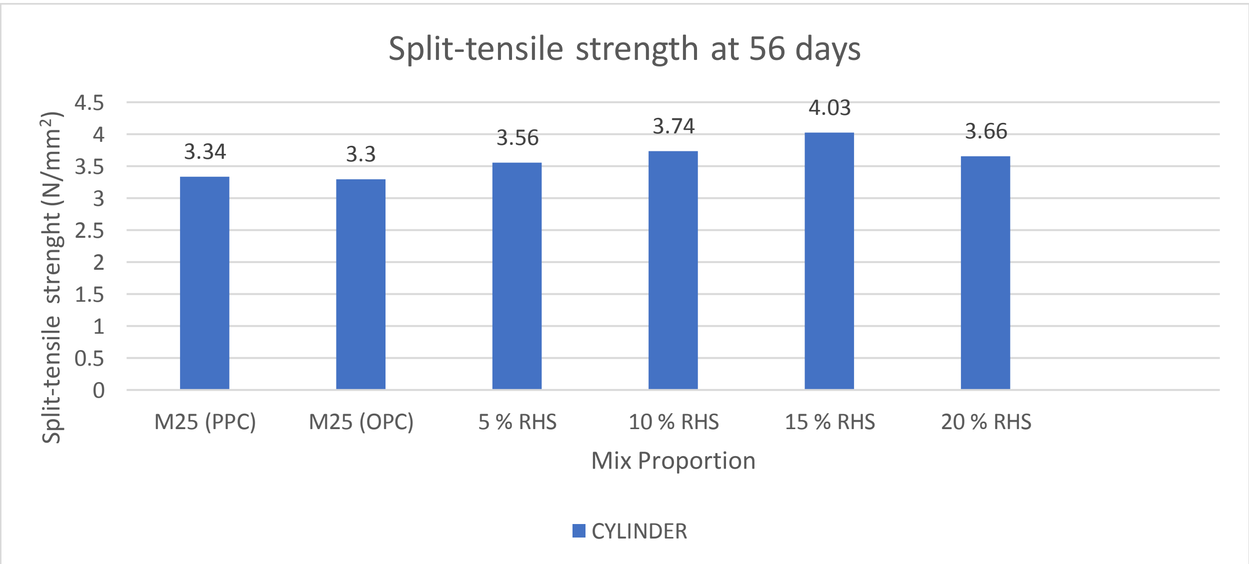

Chart-7 56day split tensile strength

V. CONCLUSION

- The replacement of Portland pozzolana cement with rice husk silica powder gives improvement in concrete properties such as compressive and split tensile strength.
- With 15% replacement of PPC by Rice husk silica powder gives maximum compressive strength 39.48N/mm^2 at 56days for cube specimens which is 18.80% increment to normal M25 control mix.
- With 15% replacement of PPC by Rice husk silica powder gives maximum compressive strength 33.78N/mm^2 at 56days for cylinder specimens which is 18.73% increment to normal M25 control mix.
- 15% replacement of PPC by rice husk silica powder gives maximum split tensile strength which is 4.03 N/mm^2 which is 20.65% increment to normal M25 control mix.
- Because of smaller particles of Rice husk silica powder the packing in concrete became denser which improves properties of concrete. Also, the pozzolanic properties of Rice husk silica powder improves the production of calcium-silicate-hydrate gel. C-S-H gel is most responsible for the strength of concrete.

VI. REFERENCES

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