Study on Mechanical Properties of Concrete using Marble Dust and Rice Husk Ash

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Abstract **- Making and utilizing of a sustainable concrete has become an important requirement day by day. To reduce the environmental effect, several of supplementary cementing and pozzolanic materials are introduced and they are partial replacement of cement in the concrete. In this work I am using two waste materials in this work namely marble powder and Rice husk ash as partially replacing with cement. Marble powder and rice husk ash both materials cheaply available in India. Cement production creates environmental problems and marble powder as well as rice husk ash creates environmental problems.so Marble powder and Rice husk ash as partial replacement with cement in concrete. This Project reports the results of the mechanical properties of the concrete with partial replacement of marble powder (0%, 5%, 10%, 15% & 20%). Partial replacement of Rice-husk ash (0%, 5%, 10%, 15%& 20%) separately and blended both marble powder and rice-husk- ash combines partial replacement (0%, 5%+5%, 10%+10%, 15%+15% & 20%+20%). The test results indicate that marble powder & rice-husk- ash is an effective mineral admixture, with 10% and combine of both (5%+5%) as the optimal replacement ratio of cement. Flexural strength and Tensile strength will be maximum at 15% replacement of both supplementary materials (Marble powder, Rice husk ash).Beyond 10% marble powder and rice husk ash the compressive strength of concrete reduces and is lower than that of control concrete.**

Index Terms **- India, Waste, Domestic Rice husk ash, marble powder, Pozzolanic materials, Concrete, Mechanical Properties.**

I.INTRODUCTION

Concrete is mixture of cement, sand, gravel, and water. Concrete is the most important material in construction industry other than timber and steel. It is estimated that current consumption of concrete in the world is of the order of 10 billion tones once a year. Peoples consumes no material except water in such tremendous quantities. Aggregates occupy 60%to 80% total volume of concrete. Mineral admixtures are often used in concrete in combination with Portland cement for development of mechanical properties, economy, and improved durability under the anticipated environment. Mineral admixtures include rice husk ash, marble powder, fly ash, brick powder, ground granulated blast furnace slag, metakaolin, silica fume and extra. Mineral admixtures are also referred as the performance improvers. The word "concrete" is originating from the Latin verb "concretus" that means to grow together. The characteristics of concrete depends upon the properties of constituent of material and their combined action. Within the production of cement CO2 gas emission is additional, so these leads to injury of natural environmental conditions. To cut back the consumption of cement partial replacement of cement with some supplementary building materials. Cement is a binding material that has adhesive and cohesive properties within the presence of water. Such type of cements is called hydraulic cement the hydraulic cement is usually known as Portland cement because of its resemblance upon hardening to the Portland rock found near Dorset, England. This name was first used by joseph Aspdin of Leeds, England in1824 in his patent.

II. EXPERIMENTAL MATERIALS

The Experimental material used are cement, rice husk ash, marble powder, fine aggregate, coarse aggregate, and water. The recommended material has been described below.

CEMENT: A cement could be a binder, a substance utilized in construction that sets and hardens and can bind other materials together. The most vital types of cements are used as a component within the production of mortar in masonry, and of a concrete,

that could be a combination of cement and aggregate to make a strong building material. Cements utilized in construction will be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set within the presence of water. Non-hydraulic cement will not set in wet conditions or under water, rather, it sets because it dries and reacts with CO_2 within the air. It will be attacked by some aggressive chemicals after setting. Hydraulic cement or ordinary Portland cement set in wet conditions and become adhesive due to chemical reaction process between the dry ingredients and water. The chemical process results in mineral hydrates that are not very water-soluble and so are quite sturdy in water as well as safe from chemical attack. This permit setting in wet condition or under water and further protects the hardened material from chemical attack. The chemical change for cement found by ancient romans used volcanic ash.

Ordinary Portland cement was invented in 1824 by an English mason; Joseph Aspdin of European country (England) is credited with the invention of recent ordinary Portland cement. He named his cement Portland when a rock quarry that created very sturdy stone. Who named his product Portland cement as a result of it produces a concrete that was of an equivalent colour as natural stone on the isle of Portland with in the English Channel. Raw materials for producing of the cement carries with it essentially calcareous, siliceous, and argillaceous material. The mixture is heated to a high temperature inside a rotating kiln to produce complex group of chemicals, collectively referred as "cement clinker" Neville (1987). Cement is distinct from the ancient cement.

ADMIXTURES: Admixture is well-defined as the material, other than cement, sand, water, and aggregates that is employed as ingredients of the concrete. Admixture is material, which is adscititious sometimes to the cement clinker at the cement mill at the time of grinding. It will be slightly troublesome to predict the effect and therefore the results of exploitation admixtures as a result of, many times the modification within the properties of cement mixture grading mix proportions of mix after the properties of concrete. Generally, several admixtures effects more than single property of the concrete. Few times more than one admixture is additionally used for concrete mix. The impact of more than one admixture is very troublesome to predict. therefore, one ought to use caution with in the choice method of the admixtures and in predicting the effect of same on concrete mix.as for the recent report of the ACI committee 212(2010) admixture have classified in to fifteen groups according type of materials constituting the admixtures, or characteristic effect of the usage.

TYPES OF ADMIXTURES

- Water-reducing
- Retarding
- Accelerating
- Water-reducing and retarding
- Water-reducing and accelerating
- High-range water-reducing and retarding, or super plasticizing and retarding

RICE HUSK ASH: Rice milling creates a by-product know as husk. This surrounds the paddy gain. Throughout milling of paddy about 78 percentage of weight is received as rice, bran, and broken rice. Rest 22 percentage of the weight of paddy is received as husk. This husk is utilized as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75% organic volatile matter and therefore the balance 25percentage of the weight of the husk is converted into ash throughout the firing method, is called rice husk ash. RHA, made once burning of Rice husk (RH) has high reactivity and pozzolanic property. Indian standard code of practice for plain and reinforced cement concrete, IS 456-2000, recommends use of RHA in concrete however does not specify quantities. Chemical composition of RHA are affected due to burning process and temperature. Silica content within the ash will increase with higher the burning temperature. As per study By Houston, D.F(1972) RHA made by burning rice husk between 600 and 7000c temperatures for two hours, contains 90-95% SiO2,1-3%K_2O and <5% unburnt carbon. Beneath controlled burning condition in industrial furnace, conducted by Mehta P.K. (1992), RHA contains silica in amorphous and extremely cellular kind, with 50-1000m2/g surface area thus use of RHA with cement improves workability and reduces heat evolution, stability, plastic shrinkage and Thermal cracking. This will increase strength development, Modifying the pore-structure impermeability and durability by strengthening transition zone, blocking

the massive voids within the cement paste through pozzolanic reaction. RHA minimizes alkali-aggregate reaction, refines pore structure, reduces enlargement, and hinders diffusion of alkali ions to the surface of aggregate by small porous structure.

MARBLE POWDER: Marble is a metamorphic rock that will be foliated or non- foliated, composed of recrystallized carbonate minerals, most typically calcite or dolomite. Geologists use the term "marble" to refer to metamorphosed limestone. But stonemason use the term more broadly to encompass unmetamorphosed limestone. The marble has been normally used as a construction material since past. Disposal of marble powder material of the marble industry, consisting of very fine powder, is one among the environmental issues worldwide now a days. During this work, a marble powder, obtained as a by-product of marble sawing and shaping, was characterized from a physical and chemical point of view for evaluating possibility of utilizing it in mortar and concrete production. Throughout the cutting process total 25% marble is resulted in dust. Rajasthan marble process enterprise produces 4500 tons marble waste yearly, which suggest that using marble waste of the Rajasthan marble process enterprise as a cement substitution material will indirectly reduce CO2 emission to the atmosphere by 4500 tons yearly. Recycling marble waste powder in substitution of sand also indirectly will reduce environmental problem related with sand production.

FINE AGGREGATE: The most common fine aggregate used in the concrete is river sand. River sand could be a very important ingredient in creating the two most usually used construction material viz. cement concrete and mortar. The sand should be clean, hard, strong, and free from the organic impurities and deleterious substances. It should be capable of manufacturing a sufficiently workable mix with minimum water- cement ratio. Historically river sand that is made by natural weathering of rocks over a few years is used as the fine aggregate. Natural sand is worn and drained particles of rocks and of various size or grades depending on the accounting of wearing. The natural and least expensive resource for sand is river. Dams are constructed on all rivers therefore these resources are reducing very fast. Now a day's good quality sand isn't readily available, it should be transported from so many distances. Those resources are also exhausting quickly. Aggregate which passes through 4.75 mm Indian standard sieve is known as the fine aggregate.

COARSE AGGREGATE: Aggregate is a very crucial material for making concrete, particularly coarse aggregate that greatly affects the concrete performance. Concrete performances, such as Drying shrinkage, permeability resistance, frost resistance, and durability are closely connected with aggregate. The aggregates are formed because of natural designation of rocks or by artificial crushing of the rock or gravel. The properties of coarse aggregate are chemical and mineral composition, spectrographic description, specific gravity, hardness, strength, physical and chemical stability, pore structure and colour. other properties of the aggregates not possessed by the parent rocks and particle size and shape, surface texture and absorption etc. all these properties could have a considerable effect on the standard of concrete fresh and hardened state.

WATER: Mixing water should be unpolluted, fresh and drinkable. Water should be free from impurities like clay, loam, soluble salts that leads to deterioration in properties of concrete. Potable water is fit mixture and curing of concrete. The amount of water in concrete controls several fresh and hardened properties of concrete together with workability, compressive strength, weathering and durability, water tightness and permeability, drying shrinkage and potential for cracking. For these reasons, limiting and controlling the quantity of water in concrete is very important for both constructability and service life.

OBJECTIVE OF PRESENT STUDY

The research work is entitled as "Study on mechanical properties of concrete using marble dust and rice husk ash" aims to improve the strength characteristics of concrete by partial replacement of cement with Marble powder And Rice husk ash.

The main objectives of the research work are outlined as below.

- To determine the physical properties of OPC 53-grade cement, Marble powder, Rice husk ash, Natural sand, and coarse aggregates.
- To determine the mix design for M40 grade concrete.

- To determine the workability of fresh M40 grade concrete by partially replacing cement with Marble powder And Rice husk ash.
- To study the effect of Marble powder and Rice husk ash on compressive, Split tensile And Flexural strength of concrete at 7, 28,56 and 90 days.
- Comparing the results with reference concrete mix.

III. PROPERTIES OF THE MATERIALS

Table 1: Physical properties of OPC 53Grade Cement

S. No	Physical tests	Obtained Values	Codal Value (IS 12269:1987)
1	Soundness	2mm	Not>10mm
2	Specific gravity	3.11	Not>3.15
3	Fineness	3%	Not >10%
4	Standard consistency	31%	-
5	Initial setting time	76min	>30 minutes
6	Final setting time	345min	Not>600 minutes

MARBLE POWDER:

Marble powder is taken from Betamcherla Marble Industry having specific gravity 2.6 finer than cement. Properties of Marble Powder as given by Astrra Chemicals Industry Chennai. Partial replacement material used in this study is Waste marble powder which is of limestone origin waste material not being recycled nor used in any industries. It also causes a serious environmental problem. Waste marble powder is an inert material which is obtained as an industrial by product during sawing, shaping, and polishing of marble powder. Marble powder physical and chemical properties are shown in table 3.2, 3.3. Colour of Marble powder is white as shown in fig 1.

S.No	Property	Value
1	Physical state	Fine powder
2	Odor	Odorless
3	Appearance	Free flowing
4	Color	Pure white
5	PH (5% solution)	6. 0
6	specific gravity	2. 6
7	Moisture	Below 0. 5%
8	Oil absorption ml/100gm	18. 20
9	Particle size	Below 90 microns

Table 3 Chemical properties of Marble powder

S.No	Chemical composition	Percentage
1	Silica (SiO2)	11.38%
2	Alumina (Al2O3)	0. 23%
3	Ferric Oxide (Fe2O3)	0. 09%
4	Titanium Dioxide	NIL
5	Calcium Oxide	45.18%
6	Calcium Carbonate	88.5%
7	Magnesium Oxide	0. 20%
8	Magnesium Carbonate	0. 42%

RICE HUSK ASH:

It is taken from Locally Available Brick Industry. Rice husk ash having specific gravity 2.25.

Figure 2: Rice husk ash

FINE AGGREGATE:

Sand as fine aggregates are collected from locally available river and the sieve analysis of the samples are done. Fine aggregate conforms to Grading Zone - II as per IS: 383-1970.

Table 4 Physical properties of fine aggregate

S.No	Property	IS 383-1970 (value)	Result value
1	Fineness modulus	2-3.5	2.74
2	Specific gravity	2.6-2.7	2.61
3	Water absorption	2%	0.26%

COARSE AGGREGATE:

Coarse aggregates are collected from locally available crushed stone 20mm size have been used in this work.

Table 5 Physical properties of Coarse aggregate

S.No	Property	IS 383-1970 (value)	Result value
1	Fineness modulus	5.5-8	7.86
2	Specific gravity	2.6-2.8	2.65
3	Water absorption	-	0.32%
4	Elongation Index	<40	26.32%
5	Flakiness Index	<35	21.52%

CONCRETE MIX DESIGN:

Concrete mix design of grade M40 have been done as per of the recommended guidelines of IS: 10262-2009.The weight ratio of mix proportion is 1:1.73:2.86 keeping water-cement ratio as 0.38.To investigate the mechanical properties of M40 grade concrete, cast with partial replacement of cement with 0%, 5%, 10%, 15%, 20% of marble powder and rice husk ash, both supplementary materials also combined replacement through the work in all mix.

Cement: Fine aggregate: Coarse aggregate

= 1: 1.73: 2.86

Table 6 Materials required for 1m3

Material mixture	Cement (kg)	FA (kg)	CA (kg)	MP	RHA	W/C	SP (%)
Reference	400	690	1142	0%	0%	0.38	-
MP5	380	690	1142	5%	5%	0.38	1.20
MP10	360	690	1142	10%	10%	0.38	1.25
MP15	340	690	1142	15%	15%	0.38	1.30
MP20	320	690	1142	20%	20%	0.38	1.35

IV. RESULTS

Individually Rice husk ash(RHA) and Marble powder(MP) are mixed as in the concrete as partial replacement to cement and the optimums are arrived at 5% RHA and % MP in compressive, split tensile and flexural strength also.

Table 7 Compressive strength (MPa) of MP+RHA concrete

S. No	MP+RHA (%)	7days	28days	56days
1	0(REF.MIX)	42.45	49.36	52.23
2	5+5	44.42	55.24	56.12
3	10+10	39.68	45.14	46.38
4	15+15	37.4	38.2	38.6
5	20+20	34	35.4	36.2

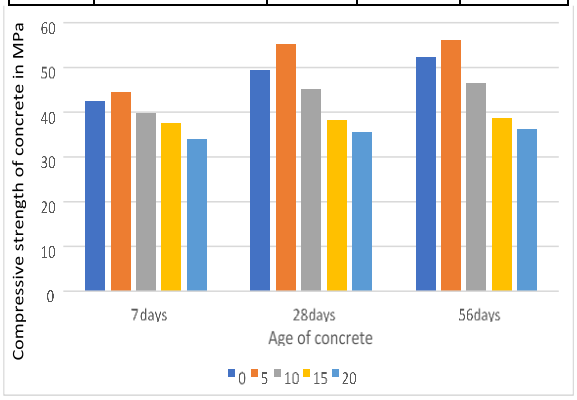

Figure 3 Compressive strength of MP+RHA concrete

Table 8 Tensile strength (MPa) of MP+RHA concrete

S.No	M.P+ RHA (%)	7days	28days	56days
1	0(REF.MIX)	3.100	3.690	3.98
2	5+5	3.15	4.10	4.20
3	10+10	2.97	3.76	3.99
4	15+15	2.95	3.51	3.62
5	20+20	2.82	3.21	3.34

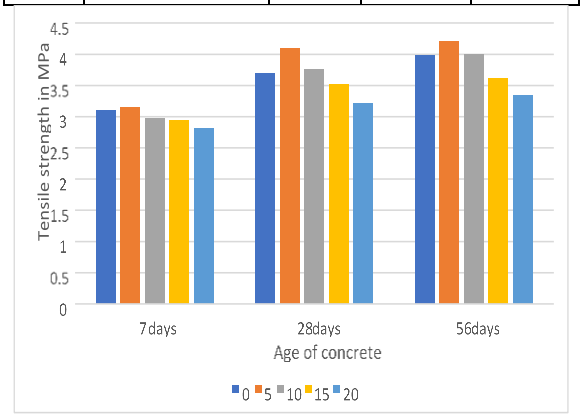

Figure 4 Tensile strength of MP & RHA concrete

Table 9 Flexural strength (MPa) of MP+RHA concrete

S.No	MP+ RHA (%)	7days	28 days	90 days
1	REF.MIX	4.91	5.1	5.27
2	5+5	5.67	6.8	6.89
3	10+10	5.45	5.56	5.78
4	15+15	4.9	5.3	5.35
5	20+20	3.8	4.12	4.45

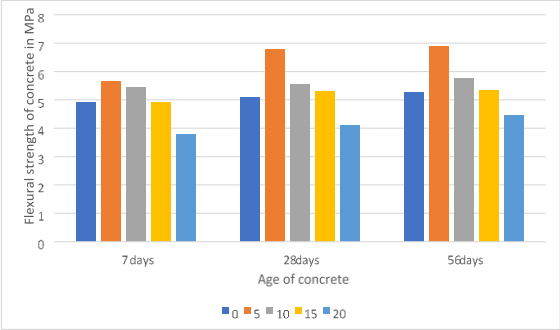

Figure 5 Flexural strength of MP & RHA concrete

IV. CONCLUSIONS

On the basis of Experimental investigation of the present research study, the following conclusions have been drawn.

- As compared Reference concrete mix the workability is initially good after decreased as percentage of RHA increased due to more fineness of RHA the voids present in the concrete are fulfilled with RHA.
- The workability for M40 grade of concrete increase in % of waste marble powder up to 20% replacement by cement.
- From the test results it has been observed that the compressive strength of M40 grade concrete attaining 2.3% more than the target strength for Reference mix concrete at 28 days. Considering the Maximum strength, cost effectiveness and performance characteristics, 10% MP and RHA replacement of cement is found to be optimum dosage in concrete making.
- The optimum compressive strength was observed at replacement percentage of (5+5) % with MP and Rice Husk Ash. For 90 days compressive strength is 5.11% more than the Reference concrete at (5+5) % replacement level.
- The optimum Tensile strength was observed at replacement percentage of 15% with Rice Husk Ash. From the test results it has been observed that the split tensile strength of M40 grade of concrete increases gradually as 3%, 3.8% and 6.8% at 5%, 10% and 15% partial replacement of cement with RHA at 28 days as compared to reference concrete.
- 6The optimum Tensile strength was observed at replacement percentage of 15% with Marble powder. From the test results it has been observed that the split tensile strength of M40 grade of concrete increases gradually as 4%, 7.3% and 8.13% at 5%, 10% and 15% replacement of cement with MP at 28 days compared to reference concrete.
- The optimum Tensile strength was observed at Replacement percentage of (5+5) % with RHA and MP. From the test results it has been observed that the tensile strength of M40 grade concrete increases 11%, 1.89% at (5+5) % and (10+10) % replacement of cement with MP& RHA at 28 days as compared to reference concrete.
- The optimum Flexural strength was observed at replacement percentage of 15% with Marble powder. From the test results it has been observed that the Flexural strength of M40 grade of concrete increases gradually as 19.6%, 61.7%% and 63% at 5%, 10% and 15% replacement of cement with MP at 28 days compared to reference concrete.
- The optimum Flexural strength was observed at replacement percentage of 15% with Rice Husk Ash.
- The optimum Flexural strength was observed at replacement percentage of (5+5) % with MP and RHA.

Cement is a building material which is used as binding ingredient in the concrete mix. But it has become as expensive commercial engineering material apart from this manufacturing of cement has great negative impact on environment. Hence it is necessary to replace the cement fully or partially, with alternative or supplementary material without violating any properties of concrete in fresh& harden state. Rice Husk Ash and Marble powder are good supplementary cement materials, which can partially replace the OPC. Usage of RHA&MP as a partial replacement of cement proved that MP&RHA are able to produce the desired properties of concrete in Fresh and Harden state. From the test results we can conclude that 10% of cement can be replaced by Rice Husk Ash and Marble powder.

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