OPTIMUM STRENGTH EVALUATION OF M 50 GRADE CONCRETE BY USING COCONUT SHELLS AND MARBLE DUST

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ABSTRACT

The increased quest for sustainable and eco-friendly materials in the construction industry has led to research on partial replacement of the conventional constituents of concrete by two selected waste materials. The broad aim of this work was to investigate the effects of partial replacement of Ordinary Portland Cement (OPC) by Marble dust as cement ,coconut shell pieces as coarse aggregate, Hence we are going to use M50 Grade mix with 0%,3%,6%,9%,12% and 15% of CSP and MD .This test is carried out to determine the properties of concrete including compressive strength, tensile Strength. etc of beams , cubes, cylinders by using Universal testing machine .As a result CSP,MD can potentially be used as coarse aggregate, and cement replacement material for structural concrete apapplications

1.INTRODUCTION

1.1General

Concrete is a construction material composed of cement (commonly Portland cement) as well as other cementations materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures. The word concrete comes from the Latin word “concretus” (meaning compact or condensed), the past participle of “concresco”, from “com-“ (together) and “cresco” (to grow). The paste fills the voids in the aggregate and after the concrete is placed and vibrated it hardens to form a solid structural member. Concrete has high compressive strength and low tensile strength. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material.

1.2 Marble Dust

1.2.1 Back Ground of Marble Dust

Growth of population, increasing urbanization and living standards have contributed to an increase in types and amounts of solid wastes generated by industrial, mining, domestic and agriculture activities. India produces around 960 million tons of solid wastes which pose a major environment and ecological problem. In this regard one of the major industrial wastes is the marble sludge produced by marble processing industries. In India, marble processing industry generates around 7 million tons of wastes mainly in the form of powder during sawing and polishing processes. These are dumped in the open which pollute and damage the environment. The pollution issue is a serious cause of concern in the state of Rajasthan since there are around 4000 marble mines and about 1100 marble cutters in medium sector spread over 16 districts of Rajasthan. The marble dust shown in fig 1.1

Fig 1.1 Marble Waste Powder

Out of the total waste generated in India, contribution from Rajasthan state itself is 95% of the total accounting to 6 million tons annually. The major marble sludge producing areas in Rajasthan are in the districts of Udaipur, Rajsamand, Banswara, Dungarpur, Jaipur Sirohi, Bhilwara, Ajmer, Bundi, Alwar and Pali. Generally the marble wastes are being dumped in any nearby pit or vacant space near the marble processing industries, although notified areas have been marked for dumping the same. This leads to increased environmental risks as dust pollution spreads alongside for a large area. In the dry season, the dust dries up, floats in the air, flies and deposits on crops and vegetation. In addition, the deposition of such generated huge amount of fine wastes certainly creates necrotic ecological conditions for flora and fauna changing landscapes and habitats. The accumulated waste also contaminates the surface and underground water reserves.

1.3 Coconut Shell

1.3.1 Back Ground of Coconut Shell

Coconuts are produced in 92 countries worldwide on about more than 10 million hectares. Indonesia, Philippines and India account for almost 75% of world coconut production with Indonesia being the world's largest coconut producer. A coconut plantation is analogous to energy crop plantations, however coconut plantations are a source of wide variety of products, in addition to energy.

The current world production of coconuts has the potential to produce electricity, heat, fiber boards, organic fertilizer, animal feeds, fuel additives for cleaner emissions, health drinks, etc. The coconut fruit yields 40 % coconut husks containing 30 % fiber, with dust making up the rest. The chemical composition of coconut husks consists of cellulose, lignin, pyroligneous acid, gas, charcoal, tar, tannin, and potassium. Coconut dust has high lignin and cellulose content. The materials contained in the casing of coco dusts and coconut fibers are resistant to bacteria and fungi. Coconut husk and shells are an attractive biomass fuel and are also a good source of charcoal. The major advantage of using coconut biomass as a fuel is that coconut is a permanent crop and available round the year so there is constant whole year supply. Activated carbon manufactured from coconut shell is considered extremely effective for the removal of impurities in wastewater treatment processes. The Coconut shell are shown in fig 1.2

Fig 1.2 Coconut shell

2.REVIEW OF LITERATURE

N. Gurumoorthy Assistant Professor in Civil Engineering, PSNA College of Engineering and Technology, Dindigul , Tamilnadu International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 3 Issue 3, March- 2014:

Influence of Marble Dust as Partial Replacement of Cement in Concrete

The main objective of this research is to investigate the performance of concretes contained marble dust as a cement replacement, mix was prepared with cement and sand blended with marble dust with replacement from 10%, 20%, 25% and 30%.The investigation indicates that replacement of cement by marble waste powder at different ranges, in concrete production, results in higher compressive strength, split tensile strength and flexural strength as of concrete specimens without marble dust. The Compressive strength, Split Tensile strength and Flexural strength are increased with marble dust up to 25% replace by weight of cement. Further any addition of waste marble dust the compressive strength, Split Tensile strength and Flexural strength are decreased .Therefore , we conclude that the most suitable percentage replacement of marble dust in concrete is 25%.Thus we found out the optimum percentage for replacement of marble dust with cement and it is almost 25% cement for cubes, cylinders and prisms .Result of this investigation that marble dust could be conveniently used in making good quality concrete and construction materials.

Ms. Ruchi Chandrakar International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 0056 Volume: 04 Issue: 05 | May -2017 p-ISSN:2395-0072

Cement Replacement in concrete with Marble Dust Powder

The requirement for locally manufactured building material has been emphasized in many countries. Environmental problems can be issued due to dumping of waste materials. The industrial marble stone generate both solid waste and stone slurry. Stone slurry generated from industries up to 15-20% of total final products during processing.

There are several reuse and recycling solution for industrial waste. The industrial wastes are dumped to the ground for improving their fertility property of soil. In this study total 42 cubes were casted. Marble product are mixed in concrete mix M-20 in different percentage (5%, 10%, 15%, 20%, 25%, and 30%) by weight. The cement was replaced by marble powder. After curing (7 and 28 days), cubes were tested. The replacement of cement with 10% of marble powder gives the maximum compressive strength at both 7 days and 28 days curing period. It was found that marble dust available at every processing plant in huge quantity and its cost is very less compared to cement. According to this study, the replacement of cement up to 10% with marble dust powder in M-20 grade of cement concrete cube the compressive strength of the cubes increased and then further increase the replacement of cement with marble dust powder there was decrease the strength .

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IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , Volume 13, Issue 4 Ver. III (Jul. - Aug. 2016), PP 01-05 DOI: 10.9790/1684-1304030105 | Page

Study on Marble Powder as Partial Replacement of Cement in Normal Compacting Concrete.

Along the rapid growth of human needs in many sectors, a significant decrease in the availability and viability of the natural resources was always faced. Neither the less, the high volume production is always associated with considerable amount of waste materials, which may adversely impacts the surrounding environment. One of the major waste generating industries is the marble quarry and production industry by 70% of this precious mineral resource is wasted in the mining processing and polishing procedures .A total of five concrete mixes, containing 0%, 5%, 10%, 15% and 20% partial replacement of cement with marble powder are investigated in the laboratory .The workability increased with increase of marble powder. The mechanical properties increased with increasing of curing days. The compressive strength increased with increase of marble powder up to 10% Replacement it was observed that 2.81%,2.92% and 4.58% of strength increased compared to normal mix with 10% replacement of marble powder at 7, 28 and 56days respectively. It was observed that 0.43%,11.6% and 5.6% of spilt tensile strength increased at 10% of marble powder compared to normal mix at 7, 28 and 56days respectively. It was noticed that 11.22%,20% and 14.8% of flexural strength increased at 10% replacement of marble powder compared to normal mix at 7, 28 and 56days respectively. Considerable reduction in strength was observed at 15% and 20% replacement of marble powder.

3.Materials Used

The materials used in the investigation and their properties are briefly discussed below.

3.1 Cement

An OPC 53 Grade K.C.P Cement was used in this investigation. The quantity required for this work was assessed and the entire quantity was purchased and stored property in casting yard. The following tests were conducted in accordance with IS codes.

1. Specific gravity (Le- Chatelier flask) (IS: 1727-1967)
2. Slump test (Slump cone) (IS: 1199 – 1959)
3. Sieve analysis (IS: 2306 (Part-1)-1963)
4. Compressive strength test of concrete (IS: 516-1959)
5. Flexural strength test of concrete (IS: 516-1959)
6. Split tensile strength test (IS: 5816-1999)
7. Ultrasonic pulse velocity test (IS: 13311 : 1992)
8. Rebound hammer test (IS: 13311-part 1, 2 (1992)
9. Water absorption test (ASTM C 642)
10. Acid and Sulphate resistance test

The cement used in this study was ordinary Portland cement (OPC)purchased from K.C.P Cement. This cement is the most widely used one in the construction industry in Chowdavaram.

Ordinary Portland Cement (OPC) is by far the most important type of cement. The OPC was classified into three grades, namely 33 grade, 43 grade and 53 grade depending upon the strength of the cement at 28 days when tested as per IS 4031- 1988. If the 28 days strength is not less than 33N/mm2, 43N/mm2 and 53N/mm2 it called 43 grade and 53 grade cement respectively. Ordinary Portland cement of 53 Grade from K.C.P Cement brand conforming to IS:8112-1989 and IS 12269 -1987 is used in this experimental work.

3.2 FINE AGGREGATE

fine aggregate used in this investigation was clean river sand and the following tests were carried out on sand as per IS: 2386-1968(iii)

Specific gravity.Sieve analysis and fineness modulus.Fine aggregates (i.e. 10 mm) and fine sand were purchased from a nearby crusher in Guntur area, which are typically the same materials used in normal concrete mixtures. The gradation test conducted on aggregates showed that they met specifications requirements.The aggregate size is lesser than 4.75 mm is considered as fine aggregate. The sand particles should be free from any clay or inorganic materials and found to be hard and durable. Silt test is carried out to specify the limits of presence of organic matter and silt in fine aggregates. It was stored in open space free from dust and water. It conforms to IS 383 1970 comes under zone II.

3.3 COARSE AGGREGATE

In this present investigation, locally available crushed blue granite stone aggregate of size 20mm and down was used and the various tests carried out on the aggregates, are given below
Specific gravity (IS: 2386-1968 part 3)Sieve analysis and fineness modulus (IS: 2386-1968 part 3)

The aggregate size bigger than 4.75 mm, is considered as coarse aggregate. It can be found from original bed Rocks. Coarse aggregate are available in different shape like rounded, Irregular or partly rounded, Angular, Flaky etc. It should be free from any organic impurities and the dirt content was negligible. There has been a lot of controversy on subject whether the angular aggregate or rounded aggregate will make Better concretes. They suggest that if at all the rounded aggregate is required to be used for economical Reason; it should be broken and then used. But the angular aggregate are superior to rounded aggregate from following two points.
It exhibits a better interlocking effect in concrete.The total surface area of rough textured angular aggregate is more than smooth rounded aggregate for the given volume.
Dried angular coarse aggregate of 20 mm maximum sized and 10 mm minimum size locally available was used for experimental

3.4 WATER

Water is an important ingredient of concrete, as it actively participates in the chemical reaction with cement. Since, it helps to form the strength giving cement gel and required workability to the concrete. The quantity and quality of water is required to be checked very carefully. Portable water is used in concrete.

3.5 MARBLE DUST

Environmentally, when industrial wastes are recycled not only the CO2 emissions are reduced but residual products from other industries are reused and therefore less material is dumped as landfill and more natural resources are saved. Fly ash, blast furnace slag and silica fume are most widely used industrial wastes in place of cement for concrete production attributed to their reactivity nature called pozzolanic behaviour. In addition to pozzolanas , other inert by-products and waste materials have been used in concrete and mortar production as inert filler for similar reasons. Among these, marble waste powder which using marble waste powder in cement and concrete production is a by-product of marble processing factory was studied by many researchers for its use in concrete and mortar production as sand replacing or cement replacing material.
Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its colour and appearance it is white if the limestone is composed solely of calcite (100% CaCO3). Marble is used for construction and decoration, marble is durable, has a noble appearance, and is consequently in great demand. Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. Marble powder can be used as filler in concrete and paving materials and helps to reduce total void content in concrete. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased. Marble dust is mixed with concrete, cement or synthetic resins to make counters, building stones, sculptures, floors and many other objects. Marble powder is not available in all the places. Despite this fact, concrete production is one of the concerns worldwide that impact the environment with major impact being global warming due to CO2 emission during production of cement. In addition to this, due to fineness of the marble powder, it will easily mix with aggregates so that perfect bonding is possible. Marble powder will fill the voids present in concrete and will give sufficient compressive strength when compared with the ordinary concrete.

3.6 COCONUT SHELL

Coconut shell is an agricultural waste and is available in plentiful quantities throughout tropical countries worldwide. In many countries, coconut shell is subjected to open burning which contributes significantly to CO2 and methane emissions. Coconut shell is widely used for making charcoal. The traditional pit method of production has a charcoal yield of 25–30% of the dry weight of shells used. The charcoal produced by this method is of variable quality, and often contaminated with extraneous matter and soil. The smoke evolved from pit method is not only a nuisance but also a health hazard. The coconut shell has a high calorific value of 20.8MJ/kg and can be used to produce steam, energy-rich gases, bio-oil, biochar etc. It is to be noted that coconut shell and coconut husk are solid fuels and have the peculiarities and problems inherent in this kind of fuel. Coconut shell is more suitable for pyrolysis process as it contain lower ash content, high volatile matter content and available at a cheap cost. The higher fixed carbon content leads to the production to a high-quality solid residue which can be used as activated carbon in wastewater treatment. Coconut shell can be easily collected in places where coconut meat is traditionally used in food processing.

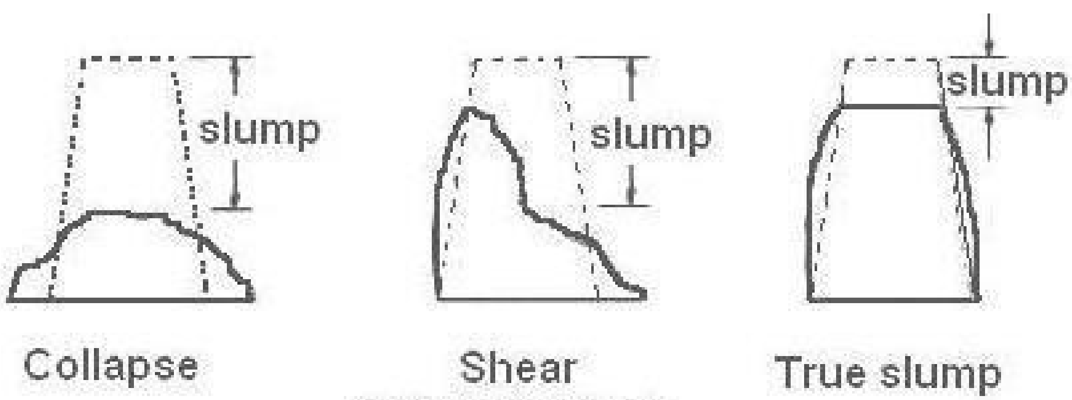
4. EXPERIMENTAL PROCEDURES

4.1 TO DETERMINE SPECIFIC GRAVITY BY PYCNOMETER METHOD:- Clean and dry the Pycnometer. Tightly screw its cap. Take its mass (M1) to the nearest of 0.1g. Mark the cap and Pycnometer with a vertical line parallel to the axis of the Pycnometer to ensure that the cap is screwed to the same mark each time. Unscrew cap and place about 200g of oven dried soil in the Pycnometer. Screw the cap. Determine the mass (M2). Unscrew the cap and add sufficient amount of de-aired water to the Pycnometer so as to cover the soil. Screw on the cap. Shake well the contents. Connect the Pycnometer to a vacuum pump to remove the entrapped air, for about 20 minutes for fine-grained soils and about 10 minutes for coarse-grained soils. Disconnect the vacuum pump. Fill the Pycnometer with water, about three-fourths full. Reapply the vacuum for about 5min till air bubbles stop appearing on the surface of the water. Fill the Pycnometer with water completely up to the mark. Dry it from outside. Take its mass (M3).

$$= \frac{M_2 - M_1}{(M_4 - M_1) - (M_3 - M_2)}$$

4.2 WORKABILITY OF FRESH CONCRETE BY SLUMP CONE TEST:-The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and any old set concrete before commencing the test. Fix slump cone to the base. The base should be smooth, horizontal, rigid and non – absorbent surface. Apply lubricating oil to inside walls of slump cone so that concrete is prevented from sticking to the walls of the slump cone. Measure the height of slump cone. Let it be "h1"cm. Preparation of concrete mix: First mix cement and sand in dry state till a mixture of uniform colour is obtain and to this mixture add coarse aggregate and again mix all the three ingredients. Then add water according to the given w/c ratio and prepare a homogeneous mix. The mould is then filled in four layers, each approximately (1/4) of the height of mould. Each layer is tamped 25 times by the tamping rod taking care to distribute the strokes evenly over the cross-section. For the second and subsequent layers, the tamping rod should penetrate into the underlying layer. After the top layer has been rodded, strike off the top with a trowel, so that the mould is exactly filled. The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction. As soon as the concrete settlement comes to a stop, measure the subsidence of concrete i.e., the difference level between the height of the mould and that of the highest point of the subsidence concrete (OR) measure the height of the concrete and let it be "h2" cm. The difference between h1 and h2 gives the slump.

Slump value = (h1-h2) cm



Types of slump

4.3 SIEVE ANALYSIS (OR) FINENESS MODULUS OF FINE AND COARSE

4.3.1 Fine Aggregate:

Take 1kg of air dried fine aggregate is sand. Arrange the test sieves in the order No.480, 240, 120, 60, 30, and 15 keeping No.480 at top and No.15 at bottom. Fix them in the sieve shaking machine with the pan at the bottom and lid at the top.

Keep sand in the top sieve (No: 480). Carry out the sieving for about 10 minutes. Find the weight of material retained on each sieve seperately

4.3.2 Coarse Aggregate:

Take 10kg of air dried coarse aggregate sample. Sieve by hand, shaking each sieve in the order of 80mm,40mm,10mm,480 micron for a period not less than 2 minutes.The shaking is done with a varied motion-backward and forward, left to right circular, clockwise and anticlockwise keeping the material moving over the sieve in frequently changing directions. Find the weights of material retained on each sieve

Maximum size present in substantial proportions (mm)	Maximum weight of sample to be taken for sieving (kg)
63	50
50	35
40 or 31.50	15
25	05
20 or 16	02
12.50	01
10	0.50
6.30	0.20
4.75	0.20
2.36	0.10

4.4 TEST ON CUBES FOR COMPRESSION STRENGTH

Cube compressive strengths tests on 150 mm size cubes at the age of 7 days and 28 days were conducted as per **IS 516.** The compressive test is the most common test conducted on hardened concrete, partially because it is an easy test to perform and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compressive strength test specimens were of dimensions 150mm x 150mm x 150mm. The specimens were tested on 2000kN capacity after 28 days of curing. The compressive test is carried out on specimens cubical or cylindrical in shape. Prism is also used but it is not common in our country. Sometimes, the compressive strength of concrete is determined using parts of a beam tested in flexure. The end parts of beam are left intact after failure in flexure and because the beam is usually of square cross section, this part of the beam could be used to find out the compressive strength. Cylindrical test specimens have a length equal to twice the diameter. The cube specimens cured as above are tested as per standard procedure after removal from the curing tank and allowed to dry under shade. The cube specimens tested under compression testing machine of 2000 KN capacity and the results are tabulated.

Compressive strength with various percentage of coconut shell and optimum 10% of Marble Dust

4.5 TEST ON CYLINDER FOR SPLIT TENSILE STRENGTH:

Of all the indirect tension test methods this method is simple to perform and gives more uniform results than other tension tests. Strength determined in the splitting test is believed to be closed to the true strength of concrete, then the modulus of rupture. Splitting strength gives about 5 to 12% higher value than the direct tensile strength. The testing arrangement and the details of testing are as follows.
The compression testing machine employed to determine the split- tensile strength of cylinder is of standard mark AIMIL. The machine has the facility of control valve by means of which the rate of loading can be adjusted. The machine has been calibrated to standard rate of loading. The patterns are cleaned, oil level is checked and it is kept ready in all respects for testing. The cylinders of size 150mm diameter 300mm height are tested for split tension using a 2000kN capacity testing machine. When the load is applied along the generatrix, an element on the vertical diameter of the cylinder is subjected to a vertical compressive stress and a horizontal stress of 2p/LD. It is observed that cylinder did split into two halves.

Split-tensile strength = $2P/\pi LD$

Where P is the maximum compressive load on the cylinder L is the length of the cylinder D is its diameter

Cylinders for spilt tensile strength

4.6 TEST ON BEAM FLEXURAL STRENGTH:
Flexural strength of the specimen is expressed in terms of modulus of rupture fcr

fcr= PL/BD^2

B = measured width in cm of the specimen

D = measured depth in cm of the specimen at the point of failure. L = length in cm of the span on which the specimen was supported P = maximum load in kg applied to the specimen.

4.7 Non Destructive Testing

4.7.1 Ultrasonic Pulse Velocity Test:

Longitudinal pulse velocity km/sec	Approximate compressive strength N/mm²	Quality of concrete
Below 2.0	----	Very poor
2.0 to 3.0	4.0	Poor
3.0 to 3.5	Upto 10	Fairly good
3.5 to 4.0	Upto 25	Good
4.0 to 4.5	Upto 40	Very good
Above 4.5	>40	Excellent

Relationship Between Ultra Sonic velocity and quaility of concrete as per IS 13311: 199

4.7.2 Rebound Hammer Test:
Before commencement of a test, the rebound hammer should be tested against the test anvil, to get reliable results, for which the manufacturer of the rebound hammer indicates the range of readings on the anvil suitable for different types of rebound hammerApply light pressure on the plunger – it will release it from the locked position and allow it to extend to the ready position for the test. Press the plunger against the surface of the concrete, keeping the instrument perpendicular to the test surface. Apply a gradual increase in pressure until the hammer impacts. (Do not touch the button while depressing the plunger. Press the button after impact, in case it is not convenient to note the rebound reading in that position). Take the average of about 10 readings.

5.Results

5.1 Specific gravity

% of coconut shell	Specific gravity value
0	2.75
3	2.69
6	2.65
9	2.61
12	2.57

15	2.52

Specific gravity value of Marble Dust with optimum 10%of Marble Dust as various component

SNo.	Material	Sp gravity
1	Cement	2.56
2	Fine Agg	2.55
3	Coarse Agg	-
4	Coconut shell	2.55

5.2 Compression Strength

s.no	% of coconut shell replaced	% of marble dust replaced	Compressive strength for 7days (N/mm²)	Compressive strength for 28days (N/mm²)
1	0	0	42.28	58.88
2	3	10	30.87	50.15
3	6	10	32.00	50.64
4	9	10	34.25	52.06
5	12	10	26.29	37.52
6	15	10	25.30	37.41

5.3 FLEXURAL STRENGTH

Percentage of coconut shell replaced for (M50)	Flexural Strength (N/mm2)
0%	11.02
3%	9.03
6%	8.6

9%	**10.5**
12%	**7.2**
15%	**6.1**

5.4 SPLIT TENSILE STRENGTH

Percentage of coconut shell replaced (M50)	**Split tensile Strength for 7days(N/mm2)**	**Split tensile Strength for 28days(N/mm2)**
0%	3.59	5.00
3%	2.62	4.26
6%	2.72	4.30
9%	2.91	4.42
12%	2.23	3.18
15%	2.15	3.17

6. Conclusion

Based on the experimental results presented in this paper, the following conclusions can be drawn:

The utilisation of coconut shell and marble dust in concrete provides additional environment as well as technical benefits for all industries. Partial replacement of coconut shell in coarse aggregate and marble dust in cement reduces the cost of making concrete up to 100 Rs per m^3 (If the marble industry is near by the site then the marble dust was free of cost so that cost of concrete reduces up to 280 Rs per m^3)

Replacement of coconut shell (3%,6%,9%10%,12%,15% as coarse aggregate) decreases the self-weight of concrete specimen and replacement of marble dust (constant 10% replacement with cement) increases the self weight of the concrete specimen.

The results of compressive strength indicated that the strength of concrete increases with respect to the replacement of coarse aggregate with coconut shell up to 9%,with constant 10% replacement of cement with Marble Dust Further additions of coconut shell caused reduction in strength due to an increase of free water content in the mix.

The results of Flexural strength indicated that the strength of concrete increases with respect to the replacement of coarse aggregate with coconut shell up to 9%,with constant 10% replacement of cement with marble dust . Further additions of coconut shell caused reduction in strength.The reason for reduction in strength was, inadequate bonding at higher coconut shell content.

As the percentage of coconut shell increases (constant 10% of marble dust), workability increases & density decreases.

Use of coconut shell and marble dust helps in waste management and dumping industrial wastes.

Compressive strength, split tensile strength & flexural strength is increased (up to an optimum of 9% replacement of CA with coconut shell and 10% replacement of cement with marble dust) due to properties of coconut shell and marble dust. (further addition of coconut shell percentages decrease the strength due to increase of moisture content)

The highest compressive strength obtained was 52.06N/mm^2 (9% replacement of CSP and constant 10% of MD as a replacement for coarse aggregate and cement respectively.

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