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STRENGTH AND DURABILITY PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH MARBLE DUST

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Abstract: Marble powder is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. The marble industry inevitably produces wastes, irrespective of the improvements introduced in manufacturing processes. In the marble industry, about 30 to 40% production waste. These wastes create many environmental dust problems in now a day to day society. In this project explained about the behavior of concrete with partial replacement of cement with added percentage values of marble powder and attain required strength. Partial replacement of marble powder in cement accordingly in the range of 5%, 10%, 15%, 20%, and 25% by weight for M40 grade of concrete. With this experimental research work the problem of waste production management of this agro waste is will be solved. It analyzed the research work the compressive strength values at 7 and 28 days. The test results show that the compressive strength are achieved up to 15% to 20% replacement of cement with marble powder without affecting the characteristic strength of M40 grade concrete. By using this marble powder as a partial replacement of cement we can reduce the cost of the concrete. For this project we have used the 20 mm size coarse aggregate and 53 grade OPC cement. When compared conventional concrete with the marble powder concrete we have achieved higher compressive strength at 15% of partial replacement of cement with marble powder.

Key words: Concrete, Marble Dust, Cement

1. INTRODUCTION

This project aims to focus on the possibilities of using waste materials from different manufacturing activities in the preparation of innovative mortar and concrete. Marble stone industry generates both solid waste and stone slurry. Leaving the waste materials to the environment directly can cause environmental problems. Advance concrete technology can reduce the consumption of natural resources and energy sources, thereby less the burden of pollutants on the environment. We describe the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. These materials, participate in the hydraulic reactions, contributing significantly to the composition and microstructure of hydrated product. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on the environment and humans. This project describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. In INDIA, the marble and granite stone processing is one of the most thriving industry the effects if varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. In this project our main objective is to study the influence of partial replacement of cement with marble powder, and to compare it with the compressive strength of M40 concrete. We are also trying to find the percentage of marble powder replaced in concrete that makes the strength of the concrete maximum. Nowadays marble powder has become a pollutant. So, by partially replacing cement with marble powder, we are proposing a method that can be of great use in reducing pollution to a great extent. Marble powder is collected from ceramic store in Ongole. The cost of the product is depending on the quantity of we taken from the store. After collecting the marble powder we should sieve the marble powder. We are using marble powder as a partial replacement of cement so we have sieve the marble powder with IS 90 Micron sieve. Cement we have taken for this project is 53 grade cement.

2. LITERATURE SURVEY

Amitkumar D. Raval1, Dr.Indrajit N. Patel and Prof. Jayeshkumar Pitroda (2013) utilization of the ceramic waste powder in various industrial sectors especially the construction, agriculture, glass and paper industries would help to preserve the environment. In this research study the (OPC) cement has been replaced by ceramic waste in the range of 0%, 10%, 20%, 30% 40%, & 50% by weight for M-30 grade concrete. Concrete samples tested and compared in terms of compressive strength to the conventional concrete. These tests were carried out to evaluate the compressive strength for 7, 14 and 28 days. Test results have reflected, the compressive strength achieved up to 30% replacement of cement with ceramic waste will be optimum without effecting properties of fresh and hardened concrete. Ponnapati. Manogna and M. Sri Lakshmi (2015)partial replacement of tile powder in cement accordingly in the range of 0%, 10%, 20%, 30%, 40%, and 50% by weight for M30 grade of concrete. For this purpose the tile concrete samples are tested and compared with the conventional concrete. The following tests are carried out, i.e., compressive strength, tensile strength and flexural strength for 7, 28 and 56 days. The test results shows that the compressive strength, split-tensile strength and flexural strengths are achieved up to 30% replacement of cement with tile powder without affecting the characteristic strength of M30 grade concrete. Electricwala Fatima, Ankit Jhamband Rakesh Kumar (2013) Ceramic dust is produced as waste from ceramic bricks, roof and floor tiles and stoneware waste industries. Concrete (M35) was made by replacing % (up to 30%) of cement (OPC 53) grade with ceramic dust (passing 75µm) shows good workability, compressive strength, split-tensile strength, flexural strength and elastic modulus. In this experimental investigation, concrete specimens were tested at different age for different mechanical properties. The results show that with water – cement ratio (0.46), core compressive strength increase by 3.9% to 5.6% by replacing 20% cement content with ceramic dust. It was observed that no significant change in flexural strength and split-tensile strength when compared to the conventional concrete. Kutegeza and Alexander (2004) from the standpoint of sustainability, use of recycled materials as aggregates provides several advantages. Landfill space used for disposal is decreased, and existing natural aggregate sources are not as quickly depleted. Leonard John Murdock 1991 Clean broken brick of good quality can provide satisfactory aggregates, the strength and density of concrete depending on the type of brick; engineering and allied bricks when crushed make quite good concrete of medium strength. Xiaoyan Huang et al (2013) used iron ore tailings powder as cement replacement for developing green ECC (Engineered Cementitious Composite) and concluded that the replacement of cement by less reactive IOTs in ECC reduces the matrix fracture toughness. Increasing the replacement of cement beyond 40% replacement ratio reduces the compressive strength of ECC.IOTs in powder form are used to partially replace cement to enhance the environmental sustainability of ECC. Mechanical properties and material greenness of ECC containing various proportions of IOTs are investigated. The newly developed versions of ECC in the study, with a cement content of 117.2–350.2 kg/m3, exhibit a tensile ductility of 2.3–3.3%, tensile strength of 5.1–6.0 MPa, and compressive strength of 46–57 MPa at 28 days. The replacement of cement with IOTs results in 10–32% reduction in energy consumption and 29–63% reduction in carbon dioxide emissions in green ECC compared with typical ECC. Ismail and Hashmi (2008) reported that the waste iron were reused to partially replaced sand at 10%, 15%, and 20% in a concrete mixers. The test performed to assess waste iron concrete quality included slump, fresh density, dry density, compressive strength and flexural strength tests. This work is functional for 3, 7, 14, 28 days curing ages for the concrete mixes. The compressive strength of the concrete mixes made of 20% waste iron aggregate increase by 22.60%, 15.90%, 17.40% for the 3, 7, 14, 28 days curing periods. Abdullah Anwar, Sabih Ahmad, S. Mohd. Ashraf Husain (2015)In this research study the 43 grade (OPC) cement has been replaced by ceramic waste powder accordingly in the proportion of 0%,5%,10%,15%,20%,25%,30% ,35%,40%,45% & 50% and fine aggregate by waste marble powder in the proportion of 0%,5%,10%, 15%,20%,25%,30%,35%, 40%,45% & 50% by weight of M-20 grade concrete. Concrete mixtures were produced, tested and compared in terms of compressive strength of the conventional concrete at 28 days. This paper presents the feasibility of the substitution of ceramic waste powder for cement and marble dust for fine aggregates to achieve economy and environment saving. "Effect of Partial Replacement of Sand by Iron Slag on Strength Characteristics of Concrete" by- ChetanKhajuria (Department of Civil Engineering Thapar university, Patiala 147004) Slag is used as substitute to previous clinker. The slag otherwise would have been a waste and used as a filler material slag, if used properly, will conserve valuable limestone deposits required for production of cement. Portland Slag Cement (PSC) has advantages of better performance, durability and optimal production cost. Tam and Tam (2006) Use of recycled/waste materials as aggregates in concrete can provide a number of advantages to stakeholders including owners, contractors, and the ready-mixed concrete and precast concrete industries. From an economic standpoint, these aggregates can be cheaper than conventional (natural and manufactured lightweight) aggregates. Use of aggregates

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made from crushed construction and demolition debris may become an increasingly attractive alternative due to rising landfill tipping fees, diminishing landfill space, and rising cost of virgin natural aggregate material.

3. CONCRETE MIX AND EXPERIMENTS CONDUCTED

Concrete is a composite material made out of fine and coarse total fortified together with liquid bond that solidifies after some time. Most cements utilized are lime-based cements, for example, Portland bond cement or cements made with other water powered concretes, for example, calcium aluminate concretes. Be that as it may, black-top solid, which is as often as possible utilized for street surfaces, is likewise a sort of solid, where the bond material is bitumen, and polymer cements are now and then utilized where the solidifying material is a polymer.

Table 4.6: Total quantity for entire project

Water (liters)	Cement (kgs)	Fine aggregate(kgs)	Coarse aggregate(kgs)	Marble powder(kgs)
22.644	53.582	53.25	176.25	7.654

EXPERIMENTS CONDUCTED ON CEMENT:

Specific gravity of cement:

Required Materials & Apparatus:

- Ordinary Portland Cement
- Kerosene
- Le-Chatelier Flask capacity of 250 ml or Specific Gravity Bottle / Pycnometer(100ml)
- Weighing balance with 0.1 gm accurate
- Why are we using Kerosene instead of water?

Formula: Specific Gravity

W_2-W1/(W2-W1)-(W3-W4)X1000

Specific gravity of kerosene is 0.79 g/cc

Fineness modulus of cement:

To describe the general coarseness or fineness of a total, an idea of fineness modulus is created. The Fineness Modulus is characterized as

Finess modulus = Cumulative retained percentage /100

Normal consistency of cement:

Vicat's Apparatus is utilized to discover the consistency, beginning setting time and last setting time of the concrete. In the ordinary consistency test we need to discover the measure of water to be added to the concrete to frame a bond glue of typical consistency.

Vicat's mechanical assembly comprises of a game plan to hold the plunger of 10 mm width and two different needles which are made to unreservedly fall into a shape loaded up with the bond glue and the measure of infiltration of the needles of loot can be noted utilizing the vertical graduations from 0 to 50 mm.

FORMULA:

Figure level of water (P) by weight of dry concrete required to plan bond glue of standard consistency by following equation, and express it to the primary spot of decimal.

P=W/C X1000

Where, W=Quantity of water

EXPERIMENTS CONDUCTED ON FINE AGGREGATE:

Explicit gravity of fine total: Apparatus:

- A equalization of limit at the very least 3kg ,clear and precise to 0.5 gm and of such a sort as to allow the weighing of the vessel containing the total and water .

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- A very much ventilated stove to keep up a temperature of 100ºc to 110ºc
- Pycnometer around 1 liter limit having a metal funnel shaped screw top with a 6mm gap at its pinnacle .The screw top will be water tight.
- A implies providing a current warm air.
- A plate of territory at the very least 32cm².
- An hermetically sealed holder sufficiently enormous to take the example.

Formula

Apprent Specific gravity = weight of dry sample /weight of equal volume of water

Fineness modulus of fine aggregate:

Table 4.7: Fineness modulus limits for various zones of sand

Sieve size	Zone-1	Zone-2	Zone-3	Zone-4
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
0.6mm	15-34	35-59	60-79	80-100
0.3mm	20-May	30-Aug	Dec-40	15-50
0.15mm	0-10	0-10	0-10	0-15
Fineness modulus	4.0-2.71	3.37-2.1	2.78-1.71	2.25-1.35

Formula

Finess modulus = Cumulative retained percentage /100

Placing, Compacting and Finishing concrete:

Take concrete from three or four arbitrary blends.

- Place concrete into form in three layers.
- Compact each layer by giving 25 blows of Tamping pole.
- Remove overabundance concrete from the highest point of shape and complete solid surface with trowel. Make the top surface of solid 3D shape even and smooth.
- Lift the shape totally undisturbed for initial four hours in the wake of throwing.
- After finishing undisturbed period, put down throwing date and thing name on the highest point of solid example with indelible marker.

Curing:

Take concrete from three or four arbitrary blends.

- Place concrete into form in three layers.
- Compact each layer by giving 25 blows of Tamping pole.
- Remove overabundance concrete from the highest point of shape and complete solid surface with trowel. Make the top surface of solid 3D shape even and smooth.
- Lift the shape totally undisturbed for initial four hours in the wake of throwing.
- After finishing undisturbed period, put down throwing date and thing name on the highest point of solid example with indelible marker.

Figure 4.11: Curing of cubes

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Fig 4.12: Compression test on the cube

Fig 4.13: Cube after compressive test

4. RESULTS

The got estimations of explicit gravity, standard consistency, beginning setting time, last setting time, fineness and compressive quality are given underneath.

Table 5.1: Properties of cement and results

Properties	Results
Specific gravity	3.15
Standard consistency	31%
Initial setting time	38minutes
Final setting time	560minutes
Fineness	7%

Table 5.2: Properties of fine aggregate and results

Properties	Results
Specific gravity	2.78
Fineness modulus	2.71%

Table 5.3: Properties of coarse aggregate and results

Properties	Results
Specific gravity	2.84
Water absorption	0.25

Table 5.4: Properties of marble powder and results

Properties	Results
Specific gravity	2.65
Fineness modulus	2.70%

5.5 Workability results of the concrete

Table 5.5.1: Slump cone results

Water cement ratio	Slump in mm
0.5	27
0.6	19
0.7	86

5.5.2: Compaction factor value for the concrete is 0.86

5. RESULTS ON COMPRESSIVE STRENGTH:

Three solid shapes of same blend extent however unique % variety of Marble powder. These are kept at a temperature of 27±2ºC for 24 hours. Toward the finish of the period 3D shapes are inundated in clean new water. The shapes are kept in water until time of testing. These 3D shapes are tried for their compressive quality following 7 and 28 days relieving in a pressure testing machine. The heap at disappointment is noted and compressive quality is determined. For 7 days and 28 days are as per the following:

S.No	Type of Mix	% of Marble Powder added	Compressive Strength	
			7 Days	28 Days
1	Normal Concrete	0	31	41.02
2	Mix 1	5	32.32	41.63
3	Mix 2	10	32.54	41.75
4	Mix 3	15	33.5	44.92
5	Mix 4	20	32.6	43.85
6	Mix 5	25	32.81	42.82

Outline 1 graphically speaks to the compressive quality of cement with incomplete supplanting of concrete with marble powder at 7 and 28 days separately. Compressive quality of marble powder

Concrete is lower to that of ordinary cement at certain rates as demonstrated as follows.

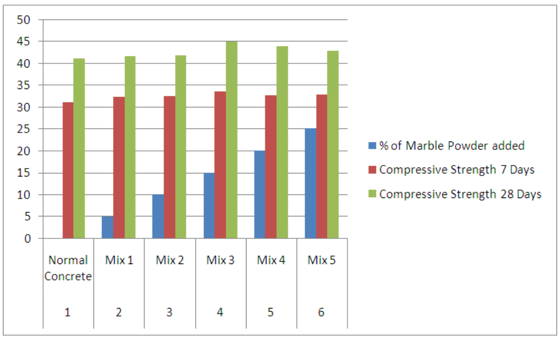

Chart 1: Compressive strength of concrete results at different % of marble powder.

6. CONCLUSION AND FUTURE SCOPE

Conclusion:

In view of trial examination the accompanying end are finished

- Addition of MARBLE POWDER to the solid blend diminishes the functionality when contrasted with typical solid blend.
- More than 15% MARBLE POWDER added to the solid blend diminishes the usefulness of cement contrasted with typical solid blend.
- Compressive quality of MARBLE POWDER concrete is lower than typical solid blend at rates above 20%.
- Compressive quality of cement at 15% substitution is more than20% quality contrasted with typical cement.
- Adding fractional substitution of MARBLE POWDER to solid blend. The Cost of work is less contrasted with typical cement.

Because of marble dust, it demonstrated to be extremely successful in guaranteeing excellent cohesiveness of mortar and cement. From the above examination, it is presumed that the marble residue can be utilized as a swap material for concrete and 15 to 20% substitution of marble dust invigorates an astounding outcome in viewpoint and quality perspective. The outcomes demonstrated that the substitution of 15 to 20% of the concrete substance by marble stone residue actuated higher compressive quality. Test outcomes show that this mechanical waste is fit for improving solidified solid execution up to 20%, upgrading new solid conduct and can be utilized in plain concrete.

Future Scope of Work

It is prescribed for future investigations that the examination on utilization of marble powder as to require to stretch out to a more extensive point of view so as to know the real conduct and successful usage of marble powder which gives a plan to consider more parameters and diverse overseeing impact of marble powder had building properties of crisp and solidified cement. This investigation can show an elective method for utilization of modern squanders by joining them into solid development obviously; the idea that the issue rises up out of urbanization and the arrangement obliges it can likewise be valued.

- Therefore, the point of this investigation is presentation of a natural well disposed innovation that can profit the general public and the country.
- Through this investigation, it is expected to land at an appropriate blend extent and percent substitution utilizing mechanical squanders locally accessible by fractional supplanting of the concrete with marble powder.

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