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Use of Waste Marble Sand in Concrete

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Abstract - *Concrete is one of the most important elements used by the construction industry throughout the world. Inflation has been seen in the case of natural sand due to its rapidly increasing demand. In such a scenario waste marble sand would be economical as compared to river sand. And thus, we can tackle one of the environmental problems worldwide today which is the disposal of the waste marble sand or powder material from the marble industry. This paper puts forward the study conducted to understand and explore the suitability of using industrial and quarrying waste marble sand (dust) in concrete as a replacement for fine aggregates. In this paper, we have replaced fine aggregates in concrete with waste marble sand of size 1-2mm (marble fine aggregates) in an M20 mix design as per IS CODE 10262. As waste marble is a low-cost product and it resembles cementitious properties, the strength of concrete is also increased than conventional concrete. It is cheap economical and eco-friendly material for the replacement of natural sand and fine aggregate*

Key Words: *Waste Marble sand, Compressive Strength, Concrete, Ecofriendly.*

1.INTRODUCTION

The term "conventional concrete" refers to the ordinary concrete that we utilize on a daily basis in India. Concrete constitutes are cement, coarse aggregate, fine aggregates, water, and sometimes an additive in the proper quantities. Hydraulic (Portland) cement, sand, stone, and water make up traditional concrete. It was invented nearly 150 years ago as a substitute material to natural stone while allowing for less labor-exhaustive shaping techniques. A stone made of calcite, dolomite, or serpentine that can be polished is known as construction marble. Marble is a term used in the construction industry to refer to any crystalline calcific rock that can be utilized as a building stone. Since ancient times marble has been widely used as a building material [8]. As a result, marble sand has been the by-product that is a critical substance, hence it requires careful environmental disposal. In addition to this, improper waste recycling can lead to environmental concerns that are worse than the waste itself. The marble manufacturing process leads to the procurement of marble sand or dust which is its byproduct. An enormous amount of marble waste is generated as a result of the cutting process. As a result, approximately one-fourth of the original marble mass is retained in the form of sand dust. Adverse effects of discharging these waste materials into the environment would lead to environmental problems such as increased human health effects, soil alkalinity, and so on. As a result, Marble sand can be considered as a replacement for sand (fine aggregates) in concrete resulting to an increase in strength of the concrete. Some of the environmental and ecological issues can be reduced if we utilize such debris to make cheaper and more lasting concrete.

Fig-1: Waste marble sand

Quarrying and processing marble results in waste marble in the form of sand, dust, and other materials, which are dumped in large quantities in landfills, causing a variety of negative environmental effects. As marble dust is a very fine-grained powder can cause soil porosity and a rise in alkalinity, as well as a decline in land fertility if buried in a landfill [5]. Because the disposal of this waste in the environment might cause numerous difficulties for the environment and human life. In this study, we have chosen to use marble in the form of sand in concrete to substitute fine aggregate sand. In the marble quarrying and processing sectors, leftover marble sand is readily available. We collected this marble trash from marble processing companies such as marble shops, factories, and quarries since waste marble sand, dust, or slurry does not easily decompose in the environment and thus generates diverse pollution that has an impact on humans health and the environment.

Fig-2: Effect of marble waste on the environment

. 2. LITERATURE REVIEW

Abdul Ghani et.al (2020) experimented by substituting sand (0–80% of sand replaced with Waste Marble Powder at increments of 20%)in concrete with waste marble powder in concrete production. Through this experiment, it was found that the mechanical properties of concrete increase up to a certain percentage of replacement, and on further replacement it decreases. The workability and unit weight of concrete decrease proportionally to the replacement percentage. With the increase in Waste Marble Powder percentage, there is a decrease in permeability.

Begashaw Worku Yifru et.al (2020) experimented normal strength concrete by partially replacing sand with marble waste and scoria. Marble: scoria ratios used were 2:1, 1:1, and 1:2. Further the combined fraction of both marble waste and scoria in concrete was increased from 33 to 67 and 100%. It was found that concrete containing marble waste and scoria as a sand replacement shows better compressive strength than conventional concrete whereas the workability and compressive strength decrease with an increase in the content of marble waste and scoria.

Nadhir Toubal Seghir et.al (2019) experimented the utilization of marble dust powder in concrete wherein a water-cement ratio of 0.50 kept constant was used in all mixes. Marble dust at various percentage (0%, 15%, 25% & 35%) with substitution by sand was made in M15 grade. The effects of the laboratory tests exhibited that both resistance to compressive load and tensile energy of concrete increased up to twenty-five percent by the substitute of cement with marble dust powder.

3. OBJECTIVES

- To find out the compressive strength of concrete using Waste Marble Sand.
- To find an alternative for natural sand with full replacement of Waste Marble Sand in concrete.

4. METHODOLOGY

Concrete with a water-cement ratio (W/C Ratio) of 0.45 is used. The cement used in this study is Ordinary Portland Cement (OPC) of 53 grade [4]. The substitution of Waste Marble Sand (WMS) will be 100% of the weight of fine aggregate. To attain enough workability, the relative ratio of coarse aggregate and sand turned was determined with respect to standard weight concrete.

Fig-3: Materials used for concrete

4.1 Characterisation of material

Ordinary Portland cement used fulfills the requirements of Bureau of Indian Standards, BIS 8112-1989. Initial setting time, final setting time, standard consistency, compressive strength and Specific gravity are given in table 1.

Table-1: Physical Properties of Cement OPC grade 53

Initial setting time	30 min
Final setting time	600 min
Compressive strength	53MPa
Standard consistency	33%
Specific gravity	3.13

The coarse aggregate used in this investigation was sourced through a local quarry. Table 2 shows the specific gravity and water absorption of coarse aggregate. The aggregate used was 20mm in size, and the chemical composition of the coarse aggregate is shown in table 3.

Table -2: Physical properties of aggregate

Type of Aggregate	Specific gravity	Water absorption % by weight
Coarse aggregate	2.60	0.55
Waste marble sand	2.70	0.05

Table -3: Chemical composition of waste marble and coarse aggregate [06].

Chemical Component	Percentage of marble waste	Percentage of coarse aggregate
LOI	45.07	5.08
SiO_2	3.75	53.70
CAO	33.12	4.83
MGO	17.91	2.01
Fe_2O_3	0.13	10.66
Al_2O_3	Traces	Nil

The marble utilised in this investigation was sourced from a nearby manufacturing facility. Table 2 shows the specific gravity and water absorption of marble waste. Table 2 depicts the chemical composition of marble trash. The investigation employed fine aggregate with a maximum size of 425 microns.

4.2 Concrete Mix proportion

The M20 concrete mix design, as defined by IS 10262-2009, is taken into account. Marble aggregate was used in place of fine aggregate in concrete. Table 4 shows the proportions of concrete in a combination. In a 160l mixer, all concrete mixes had been mixed for five minutes prior to adding water to achieve a radical homogenous mix.

Table-4: Mix Design as per IS (10262-2009) M20 Grade

Material	Qty /m³ (in kg/m³)
Cement	413
Marble Sand	722
Coarse Aggregate	1135
Water	119
W/ C ratio	0.45

4.3 Casting and Curing of Specimens

To evaluate the compressive strength, a 150mm concrete cube was cast in a typical 150mm square mould. The material was weighed, batched in accordance with the mix design as specified by the IS code. A specimen of 150mm cubes was cast. The moulds were filled in three layers, with each layer compacted by a vibrating table, as per BIS 516-1959 technique [7]. After casting, all specimens were demoulded and cured in water for 24 hours. The compressive strength test was carried out after 7 days, 14 days, and 28 days.

Fig- 4: Casting of specimen

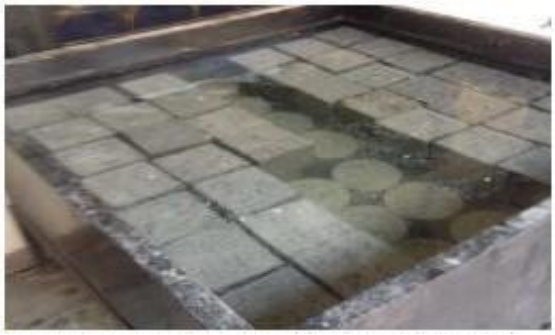

Fig-5: Curing of specimen

4.4 Test procedures

4.4.1 Slump Cone test

The slump cone test was done as per IS CODE 1199: (1959) to study the consistency of concrete with standard apparatus.

4.4.2 Compressive Strength test

As per BIS 516-59, Compressive strength for 7days, 14days and 28 days was determined for concrete specimens. The capacity of digital compression testing machine used was of 1000kN

5. RESULTS AND DISCUSSIONS

5.1 Slump Cone Test

From the slump cone test, true slump measured was 10 mm.

Fig-6: Slump Cone Test

5.2 Compressive Strength

Average Compressive Strength of two specimens tested in 7, 14, 28 days are given table 4 below.

Table- 5: Compressive Strength of Concrete Specimen

Average Compressive Strength	In days after curing	Average Load applied on specimens
26.38 N/mm2	7 Days	595 kN
34.44 N/mm2	14 Days	774 kN
43.95 N/mm2	28 Days	1000 kN

Fig -7: Concrete Testing on Compression Testing Machine

The weight of obtained concrete block was weighed and was about 8.91 kg after 28 days curing. The weight of conventional concrete block is about 8.5kg with same mix after 28 days curing.

Fig-8: Weight of waste marble sand concrete block

6. CONCLUSIONS

Experimentation led to the following conclusions

- The workability of concrete mix increases according to the amount of fine aggregate being replaced by marble waste sand and the compressive strength also increases until 100 percent of waste marble sand is added as fine aggregate.

- High-strength concrete components such as paver blocks, railway sleepers, stiff pavement, and so on can be produced as the weight of concrete is 5% more than conventional concrete.

In Rajasthan and other parts of India, large volumes of marble refuse are available. This trash can be used in the production of concrete mixtures, which is both cost-effective and environmentally friendly.

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