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Experimental Investigation in Concrete by Partial Replacement of Sand with Marble Dust

Achint Verma*, Devi Charan Dubey **

*M.Tech, Civil Engineering, Lucknow Institute of Technology, Lucknow, India.

**Assistant Professor, Civil Engineering, Lucknow Institute of Technology, Lucknow, India.

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Abstract:

Concrete is the construction material that is used the most often due to its adaptability; in addition, it is used rather frequently for the purpose of giving protection against compressive stresses. This is one of the primary reasons why concrete is used so frequently. Because the extraction of sand and the use of it both have an increasing number of negative impacts on the environment that they are surrounded by and lead to a rise in the amount of money that must be spent, The Sand is made by a procedure that is one hundred percent organic in its make-up. The mining of sand in the Narmada River is fraught with peril since there is always the chance that natural disasters would befall the region in which the sand is being mined. It is of the highest significance that we make ourselves prepared to deal with this issue in the time that is yet ahead of us. Due to the fact that this occurred, we are now searching through the marble dust. Marble Dust is a developing composite material that will make it possible for the concrete industry to make the most efficient use of its raw resources, enjoy economic benefits, and create structures that are durable, long-lasting, and environmentally conscious. In addition, the use of this material will make it possible for the concrete industry to create structures that are durable, long-lasting, and environmentally conscious. Sand was used in lieu of marble dust in the M20 (1:1.5:3) grade concrete at percentages of 0%, 5%, 10%, 15%, and 20% by weight of sand respectively. These percentages refer to the amount of sand, not the weight of the concrete. These percentages are not based on the weight of the sand but rather the quantity of it. Experiments were carried out on concrete mixes, and the data that was collected from those experiments was analyzed and compared in terms of the compressive strength of ordinary cement concrete after 7 days and after 28 days for cubes that measured 150 millimetres on a side, 150 millimetres on a face, and 150 millimetres in height.

***Keywords* — Cement, Concrete, Marble Dust, Partial Replacement, Durability, Compressive Strength, Flexural Strength, Split Tensile Strength.**

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1. INTRODUCTION

Since ancient times, marble dust and other by-products have been utilized as an essential component of a broad range of building materials. This use of marble dust and other by-products is still common today. Marble powder is a waste product that is produced as a by-product by a variety of industries and is then discarded as garbage. A material that is made up of extremely fine powder is referred to as "marble powder," and this phrase is used to describe the substance. Which component is to blame for the environmental difficulties that are now being encountered on a global scale? When dealing with large blocks of marble, it is required to break them up into smaller pieces before working with the marble itself in order to get the appropriate smooth form for the marble. The process of cutting marble results in the

loss of around one quarter of the entire mass of the marble, which is turned to dust. At this point in time, the idea that waste marble is one of the things that contribute to environmental concerns on a worldwide basis is fairly general known. Therefore, the most efficient utilization of marble waste in a variety of industrial sectors, most notably the construction, agricultural, glass, and paper industries, would contribute to the preservation of the natural environment. This is because marble waste can be recycled into other products that can be used in these industries. Because of how productively such usage would be put to use, this would be the outcome. Concrete is the building material that is used in the activity of civil construction at a rate that is much greater than that of any other material. This rate is significantly higher than the rate at which any other material is utilised. This is due to the fact that concrete offers very high levels of tensile strength in addition to structural stability. Cement, coarse aggregate, fine aggregate (often referred to as sand), and water are the basic components that go into the making of concrete. Cement is the most crucial of these primary components. Concrete is held together by a binding chemical known as cement. Not only does aggregate have the potential to lessen the strength of concrete, but it also has the potential to influence both the length of time concrete will remain functional and how well it will perform. This is because aggregate has the potential to influence both the strength and the performance of concrete. The addition of marble powder to regular concrete would result in an improvement in the material's mechanical and physical qualities. This would be a benefit to the ordinary concrete. The difficulties that are involved with waste disposal may be considerably mitigated in the event that waste marble powder could be employed as a cementation ingredient in the manufacturing of concrete. The fast construction of infrastructure in emerging countries has resulted in a shortage of sand and an increase in the cost of the material. As a result, the demand for sand is quite strong in these modern times in developing nations. As a direct consequence of this, the cost of the component has gone up. If waste material can be recycled into the manufacture of concrete, then the whole cost of building will go down, which will result in cheaper costs for consumers as a direct consequence of the decrease in overall construction costs.

2. LITERATURE REVIEW

[1] Deepanshu Patel- An investigation came to the conclusion that businesses are releasing a large number of wastes into the environment, which in turn causes a great number of issues relating to people's health as well as the health of the ecosystem. This conclusion was reached as a result of the findings of the investigation. [There must be other citations for this] As a direct consequence of this, it is vitally important to look for a solution that will react to the issue that is presented by the discharge of these pollutants. This is a direct result of the fact that the problem has been caused by the discharge of these pollutants. Marble dust powder is a kind of inert material that may be formed as a byproduct of many industrial processes involving the grinding, cutting, and polishing of marble. These processes produce marble dust. The creation of marble dust powder is a possibility at the end of this procedure. At the conclusion of this process, you may have the opportunity to produce marble dust powder. Marble dust is one factor that contributes to a wide range of environmental problems; hence, it should be avoided whenever and wherever it is practicable to do so. It is feasible to make use of these wastes as components of concrete if a portion of the cement in a mixture is replaced with the waste material instead. This not only makes the process more cost-effective, but it also helps to keep our natural resources in good condition, so it's a win-win. The major objective of this investigation is to carry out an investigation with the primary objective of evaluating whether or not marble powder might be successfully integrated in the production of concrete. This is the fundamental goal of this research. The purpose of this study was to determine the optimal percentage of replacement by weight with marble powder in a variety of amounts (0%, 5%, 10%, and 15% respectively). To accomplish this, marble powder

was substituted for cement in three different kinds of M25 concrete mixes in varying proportions (0%, 5%, 10%, and 15% by weight). These ratios were given in terms of a percentage of the concrete mixture's overall weight.

In a series of studies, the compressive strength of various Concrete mixes is tested 7 and 28 days after mixing, and the results are compared to those of the Control Concrete. The outcomes of the study that was carried out indicate that using marble powder as a substitute for cement in building projects has the potential to be a productive endeavour that need to be pursued. After putting the material through its paces in a battery of tests, it was found that the optimal level of compressive strength could be achieved by combining a percentage of 10% marble dust powder with a curing time of 28 days. This was determined after the material was put through its paces in a battery of tests. After conducting a number of tests on the substance, it was shown to have these characteristics. In spite of what may seem to be a logical expectation, the amount of required setting time for concrete does not change in any way once marble dust has been included into the mixture.

[2] Abdullah Anwar et al- Over the course of the most recent few years, there has been a rise in the total quantity of residues that have been generated by businesses and the construction sector. The vast bulk of this wasteland has been covered over since nobody bothered to investigate whether or not it was possible to reuse or recycle the material. These materials may now be employed in the manufacturing of concrete as a result of the large improvement in compressive strength that occurs as a direct consequence of the use of Marble Dust Powder (MDP) as an alternative to cement. For the purpose of this study and examination, ordinary Portland cement (OPC) was replaced with modified Portland cement (MDP) in the following weight percentages: 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, and 50% of the total weight of M-20 grade concrete. The weight of the concrete served as the basis for calculating these percentages. Following a period of 28 days, the compressive strength of the concrete mix was measured and contrasted with that of the conventional concrete. This project's objective is to examine and evaluate the impacts on the behavior and durability of concrete brought about by partly substituting cement with either MDP or both of these materials. The primary objective of this research is to identify and evaluate the characteristics of the compressive strength of M20 grade ceramic waste powder concrete and marble dust powder concrete with a water-to-cement ratio of 0.50 with the intention of developing a substitute that is more efficient and productive. On the basis of the findings obtained from experimental study about the compressive strength of concrete, one may draw the following conclusions:

The addition of marble dust powder to a typical batch of concrete results in a decrease in the typical compressive strength of the material as compared to the mix. Because of this, the marble dust powder has been replaced with up to 20% more cement by weight, but the exceptional strength of M20 grade concrete has not been altered in any way as a result of this change. Each further substitution of cement with marble dust powder results in a decrease in the material's compressive strength.

3. PROCESS OF WORK

Step-1: At this point in the production method, Sand is partially substituted with Marble Dust in variable percentages, as shown in the table that follows this explanation. Marble Dust is another component that has a function at this stage of the process. One of the batches is a conventional concrete mixture, which is one of the five batches that are combined, each of which has a different ratio of the materials (Cement as binder, Sand as fine aggregates & Natural Coarse Aggregates). In order to evaluate the compressive strength, split tensile strength, and bond stress of the material at 7 and 28 days, castings of cubes and cylindrical forms are used.

Table – 1: Formulation of work (Stage-1)

Batch Mix.	Cement (%)	Marble Dust (%)	Sand (%)	Aggregate (%)
1	100	0	100	100
2	100	5	95	100
3	100	10	90	100
4	100	15	85	100
5	100	20	80	100

Step-2: In addition, the work density of concrete is calculated and analyzed for each of the five different types of mixes in order to establish whether or not the concrete in question is considered to be lightweight. When measured in cubic meters, the density of lightweight concrete is lower than 2200 kilograms per cubic meter (kg/m3).

4. METHODOLOGY

During the first stage of the process, casting of cubes and cylinders takes place concurrently with the manufacturing of five batches of binders, the amounts of which are subject to variation. During this time, part of the sand that was there before is being replaced by dust made of marble. This has been happening at the same time as what is taking place at the moment. The information that was obtained and then analysed, with the degree to which it provided the needed attributes being taken into account for the subsequent stage in the process. This information was taken into consideration in order to complete the process.

Testing of materials: - Concrete (M-20)

1. Slump Test for concrete
2. Compressive Strength Test
3. Split Tensile Test
4. Bond Test of Concrete Test Procedure (IS-227-1967)

5. MATERIAL CALCULATIONS

(A) Material for one Concrete cubical mould:-

Total volume of concrete Mould =0.15 x 0.15 x 0.15 = 0.003375 m3
Dry Volume of concrete = 0.003375 m3 x 1.52 = 0.00513 m3

$$Cement = \frac{0.00513}{5.5} x\ 1\ x\ 1500 = 1.399\ kg = 1.4\ kg$$

Sand = 2.1 kg

Natural Course Aggregate = 4.2 kg

Note: -Extra Material used 10% for total weight of material.

(B) Material for one Concrete cylindrical mould:-

Total Volume of cylindrical Mould = 0.005302 m3
Dry Volume of concrete = 0.005302 m3 x 1.52 = 0.00806 m3

$$Cement = \frac{0.00806}{5.5} x\ 1\ x\ 1500 = 2.198\ kg = 2.2\ kg$$

Sand = 3.3 kg

Natural Course Aggregate = 6.6 kg

Note: - Extra Material used 10% for total weight of material.

Figure-1: Slump Test

Figure-2: Compressive Strength Test

Figure-3: Split Tensile Test

Figure-4: Bond Strength Test

6. RESULTS & ANALYSIS

The result of the experimental work are given below in the form of the table, the result is taken at the 7 and 28 days.

Table-2: Experimental Results

Mix.	Days	Slump Value (mm)	Bond Strength(N/mm2)	Compressive Strength (N/mm2)	Split Tensile Strength (N/mm2)	Density (kg/m3)
1	7	82	3.45	13.73	2.74	2359
	28		5.05	21.62	4.01	
2	7	70	3.6	16.65	2.56	2162
	28		4.95	25.52	3.71	
3	7	75	4	17.46	2.35	2314
	28		5	25.86	3.38	
4	7	72	4.05	17.01	2.93	2460
	28		5.8	25.93	4.02	
5	7	65	3.25	13.04	2.71	2404
	28		5.25	21.76	3.74	

7. OUR RECOMMENDATION

The recommendation result of this research work are given below in the form of the table-03

Table-03: Recommendation Value of Work

S. No.	Experimental Study	Plane Concrete		Mix Concrete	
		Mix	Value	Mix	Value
1.	Slump Cone Test	Mix -01	82 mm	Mix-04	72 mm
2.	Compressive Strength Test	Mix -01	21.62 N/mm^2	Mix-04	25.92 N/mm^2
3.	Split Tensile Strength Test	Mix -01	4.1 N/mm^2	Mix-04	4.1 N/mm^2
4.	Bond Strength Test	Mix -01	5.05 N/mm^2	Mix-04	5.8 N/mm^2
5.	Density Test	Mix -01	2310 Kg/m^3	Mix-04	2310 Kg/m^3

8. CONCLUSIONS

After 7 and 28 days of curing, a predetermined quantity of marble dust is added to concrete

mixtures in order to evaluate the compressive strength, split tensile strength, bond strength, and density of concrete mixes. This is done in order to ensure that the concrete mixes have the proper characteristics. This is done in order to facilitate a comparison of the outcomes. Sand can be used to replace anywhere from 0% to 20% of the weight of marble dust in concrete. This can be done anywhere from 5% to 20% of the weight of marble dust. As a direct result of this investigation, the appropriate percentage of Marble Dust to Sand ratio for concrete is established to be 5% (by weight of Sand), and other concrete properties are explored as a direct result of this study. This investigation was carried out in order to determine the appropriate percentage of Marble Dust to Sand ratio for concrete. After all of the tests have been performed and the results of those tests have been analysed, one could arrive at the following conclusions:

1. The marble dust that was used in place of 10% of the sand in mix-03 was responsible for the greatest gain in compressive strength that was attained. As a direct consequence of this, the mixture was composed entirely of marble dust.

2. The most significant improvement in the bond strength of the concrete was achieved with the use of marble dust in place of fifteen percent of the sand in mix-04. The outcomes of the mix were analysed, and then this conclusion was drawn.

3. The material's split tensile strength reached its maximum level when 15% of the Sand (mix-04) was replaced with Marble Dust based on the weight of the Sand. This was the case when the material reached its greatest level.

Marble dust might be used in lieu of cement and aggregate in concrete, which would bring the overall material prices involved with the building project down to a lower total. Marble dust may be acquired at a reasonable price, and there is a substantial quantity of industrial waste that contains marble dust. This kind of concrete, which we call "Marble Waste Concrete," may be used in industrial or rural regions, in addition to locations that have an abundant supply of marble dust. Other places that may use this type of concrete include sites that have an abundance of marble dust. Locations that have a plentiful supply of marble dust are another kind of location that is appropriate for its use. It is also possible to use it as an alternative to materials like cement and traditional aggregate in areas with high pricing for those two building supplies. As a direct result of this, there is the possibility for cost savings in the building and construction industry. In addition to this, Marble Dust has the ability to be categorised as a medium-weight structural concrete. If we reinforce the concrete with marble dust, which can be obtained at a low cost or is freely available, we are able to decrease environmental waste and improve split tensile strength in the case of 5% marble dust. This is because marble dust is obtained in one of two ways: either it is freely available or it can be obtained at a low cost. This is due to the fact that marble dust is either easily accessible for no cost at all or may be purchased for a very cheap price.

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