STUDY ON THE PROPERTIES OF CONCRETE BY INCORPORATING METAKAOLIN AND MARBLE DUST

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ABSTRACT: *Despite the availability of numerous admixtures, India has conducted limited research on the usage of natural admixture Metakaolin and marbledust for considerable bond progress. MK and marbledust accumulation is a mineral combination whose full prospective has so far to be explored. MK is a worth full cementitious matter made by the heat treatment of kaolin trademark shops. Because to its identical structure and high surface district, MK has a strong pozzolana reactivity. On the other hand, one of the current natural difficulties is the movement of marbledust from the marble industry. In this investigation, MK (Metakaolin) was used to partially substitute cement at 0 percent, 0%, 5%, 10%, 15 %, 20% and 0%, 5%, 10%, 15%, 20% (constant) with Marbledust. Concrete constructed with MK-Marbledust was compared to ordinary concrete of grade M40 in expressions of compressive, tensile and flexural strength. With the inclusion of MK and Marbledust, the result demonstrates an increase in strength. At 10% MK and 10% Marble dust, the optimal strength value of concrete was attained for all compressive, split tensile and flexural strength.*

Keywords:- Marble powder, slump, compressive strength, split tensile strength and flexural strength.

1. INTRODUCTION:

Structural Engineering oversees the design, construction, and maintenance of the physical and typically assembled environment, encompassing works such as roadways, dams, parks, and diversion, as well as bridges and other structures. Because a large amount of bond is used in various construction projects, concrete is one of the mainly broadly used construction materials on the world. As a result, it has been aptly dubbed the spine of a country's fundamental progress. A massive volume of cement is required to fulfil this rapid foundation development. Cement is a combination material that has a reasonably elevated compressive strength but a lower stiffness. The solid development sector is now unprofitable for a variety of reasons. It begins by devouring vast quantities of virgin materials that can last for aeons. Furthermore, the most important folio in cement is Portland bond, whose production is a significant booster of ozone-depleting chemical emissions that are contributing to global temperature rise and environmental change. Finally, many strong buildings suffer from a lack of resilience, which might cause the assets to be squandered. Bond is a significant component of cement, and it is one of the three primary producers of carbon dioxide, a significant ozone depleting material. For each tonne of cement, around 900kg of CO2 is released.

After appropriate heated treatment, the major sources of METAKAOLIN are kaolin clay. The appropriate temperature for warming kaolin in order to obtain METAKAOLIN with a high pozzolanic material varies from one expert to the next. The length of time it will take for the climate to warm is also unknown. Warming kaolin to get METAKAOLIN can take place at temperatures ranging from 600^0 c to 850^0 c degrees Celsius for times ranging from 1 to 12 hours. In conventional stone preparation facilities, a large amount of marble residue is created, which has a substantial impact on the environment and people. The effects of different marble residual matter on the physical and mechanical characteristics of fresh and hardened cement have been investigated. Marble and rock stone preparation is one of the largely blooming industries. The slump and air content of fresh concrete, as well as the assimilation and compressive strength of hardened concrete, were investigated.

1.1. OBJECTIVE:

1. To investigate mechanical qualities such as compressive strength after 7, 14, and 28 days of curing by partly substituting metakaolin and marble powder for cement in the typical curing process.
2. To lessen pollution in the environment
3. The purpose of this project is to investigate the qualities of fresh pollution by incorporating waste substance into concrete.
5. To make ecologically friendly concrete by employing metakaolin and marble dust in the casting process.
6. This is cast with metakaolin and marble dust to explore the characteristics of new concrete.

1.2. LITERATURE REVIEW

Abdullah Anwar et.al (2014) claimed that Marbledust has replaced (OPC and PPC) cement in proportions of 0%, 5%, 10%, 15%, 20%, and 25% by weight, and that M-20 grade concrete be used. M30 concrete is used. In terms of compressive strength, combinations were designed, tested, and compared to standard concrete. The goal of this study is to look at how concrete behaves when Marbledust is replaced with dissimilar quantities in concrete. The 28-day compressive strength result reveals that the appropriate proportion for replacing cement with marble dust powder is around 10% for (PPC) and (OPC). As a result, carbon dioxide emissions will be reduced, and environmental pollution will be reduced as a result of cement manufacture, which will improve the built-up environment. Sanjay N. Patil et.al(2014) that the study discusses the usage of Metakaolin, which has significant pozzolanic action and is a useful matter for high-strength concrete construction. Because of its beneficial influence on many concrete qualities, MK is becoming increasingly popular. According to the literature review, best performance is came from by substituting 7% to 15% of the cement with Metakaolin, and if MK is used less than 10%, the advantages are not completely realized, thus at least 10% Metakaolin must be utilised. After 28 days, the compressive strength of concrete containing Metakaolin might increase by 20%. Workability is reduced when 15 percent Metakaolin is used. To ensure a longer period of workability, increasing the perceptual fraction of Metakaolin in concrete mix appears to necessitate a elevated dosage of superplasticizer. J.M. Khatib et al. (2012) investigated the compressive strength, density, and ultrasonic pulse velocity of mortar containing a large proportion of Metakaolin (MK) as a partial cement substitute. Prof P.A. Shirule et.al (2012) that the viability of employing marble sludge dust as a fractional replacement for cement in concrete production was discussed in the article. With the adding up of waste marble powder up to 10% by weight, the compressive strength of cubes and split tensile strength of cylinders were raised, and it was also discovered that 10% substitution supplied the best substitution rate of strength.

2. MATERIALS:

2.1. Cement: In this project, ordinary Portland cement 53 grade according to IS 8112 -2013 is used. The results of the cement test are displayed in the table below.

Table 1. Properties of Cement

S.NO	PHYSICAL PROPERTIES	TEST RESULTS
1.	Specific Gravity	3.10
2.	Standard Consistency	33%
3.	Initial Setting Time	33 minutes.
4.	Final Setting Time	356 minutes.
5.	Fineness of Cement	2%

2.2. Metakaolin: Metakaolin is a pozzolanic substance that is arguably the most effective for usage in concrete. It is generated while china clay, the mineral kaolin, is heated to a temperature among 600°C and 800°C. It is a result that is put on for use rather than a by-product.

Table 2. Properties of Metakaolin

Properties	metakaoline
Specific gravity	3.28
Bulk density	1005kg/m3
Percentage of Void	41.83%
Fineness modulus	2.84

2.3. Marble dust: In igneous and metamorphic rocks, it is a necessary component. The size ranges from metric tonne specimens to microscopic particles that glisten on granite surfaces. The crushed marble powder utilised in the trials is a white powdered form that is used to substitute fine aggregate in traditional concrete. The particle size varies from 10 to 45 micrometres.

Table 3. Properties of Marble Dust

Properties	Marble dust
Specific gravity	2.56
Bulk density	1340kg/m3
Percentage of Void	46.58%
Fineness modulus	3.38

2.4. Fine aggregate: Sand that was readily accessible was utilised. According to IS: 383-1987, the sand complied with zone IV. Below table shows the features of fine aggregate.

Table 4. Properties of Fine aggregate

S.NO	PHYSICAL PROPERTIES	TEST RESULTS
1	Specific Gravity	2.60
2	Water absorption	0.87%
3	Bulk Density	1.61 g /cc
4	Silt Content	2.67 %
5	Impact value	12.71%
6	Fineness Modulus	3.82

2.5. Coarse aggregate: Crushed aggregate was obtained from a nearby quarry. The aggregate utilised in this experiment was 20mm down and tested according to IS: 2386- 1963(I, II, III) specifications. Table determination shows the parameters of coarse aggregate. The attributes of coarse whole are shown in the table below:

Table 5. Properties of Coarse aggregate

S.NO	PHYSICAL PROPERTIES	TEST RESULTS
1	Specific Gravity	2.70
2	Water absorption	2.22%
3	Bulk Density	1.68
4	crushing value	13.98%
5	Impact value	12.71%
6	Fineness Modulus	7.89

3. METHODOLOGY:

3.1. Workability: The ease and uniformity with which it may be mixed, put, cemented, and completed is determined by the workability of freshly mixed concrete.

a) Slump cone test

The slump test is the most popular way of determining concrete consistency, and it can be done in the lab or on the job site. It's not a good idea to use it on extremely wet or very dry concrete. It does not account for all aspects that influence workability, nor does it always reflect the concrete's placeability.

b) Compaction Factor Test

The compaction factor test is a laboratory-based concrete workability test. The weight ratio of partly compacted to fully compacted concrete is known as the compaction factor.

3.2. Compressive Strength: Concrete's compressive strength is tested on a cube at various marble powder content percentages. Concrete strength was evaluated on a cube after 7 days, 14 days, and 28 days of curing. The 7-day test was used to find out the increase in starting concrete strength, the 14-day test was used to find out the increase in median concrete strength, and the 28-day test was used to determine the final concrete strength after 28 days of curing. The compressive strength of concrete is tested using a compression testing machine. The cube is in use out of the water and dried before being examined, with the smooth faces in the top and bottom parts.

Compressive Strength = $\frac{Applied\ Load}{Cross\ Sectional\ Area}$

3.3. Split Tensile Strength: On cylinders, the split tensile strength of concrete is evaluated at various percentages of marbledust content in concrete. Concrete strength was evaluated on a cylinder after 7 days, 14 days, and 28 days of curing. A seven-day test was carried out to determine the increase in concrete's initial strength. The 28-day test determines the concrete's ultimate strength after 28 days of curing. The Split Tensile strength test on concrete is performed using compression testing equipment. The cylinder was taken out of the water and dried before being examined.

Split tensile strength = $\frac{2P}{\Pi DL}$

3.4. Flexural Strength: The flexural strength of concrete is evaluated on beams at various marble powder content percentages. Concrete strength was evaluated on beams after 7 days, 14 days, and 28 days of curing. A seven-day test was carried out to determine the increase in concrete's initial strength. The 28-day test determines the concrete's ultimate strength after 28 days of curing. The Flexural strength test on concrete is performed using a loading frame machine. The beams were hauled out of the water and dried before being examined.

Flexural Strength = $\frac{3PL}{2bd\text{^}2}$

4. RESULTS:

4.1. Slump cone test results:

Table6. slump values

	MK+ MP (0%)	MK+ MP(5%)	MK+ MP (10%)	MK+ MP (15%)	MK+ MP (20%)
Slump @ 0Min	110mm	104mm	100mm	90mm	82mm
Slump @ 30Min	98mm	98mm	94mm	88mm	75mm

The highest slump obtained was 110 mm, and the lowest slump was 82 mm, according to the results. Each batch of mix had an average slum of 96 millimeters. As a result, the intended slump was attained, with a range of 50 mm to 120 mm. The workability was good, and 0 percent metakaolin and marble dust up to 20% could be handled well. Because the reduction in the range of 5 mm to 9 mm from 0% metakaolin and marble dust to 20% was regarded moderate, the slump was considered moderate.

4.2. Compaction factor test results:

Table 7. Compaction factor values

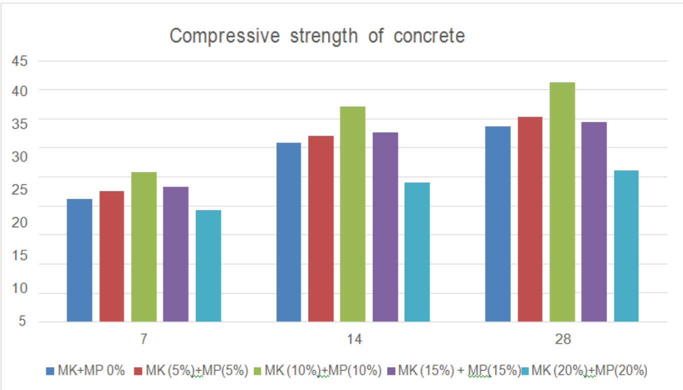
Metakaolin and marbledust	0%	5%	10%	15%	20%
Compaction factor	0.91	0.895	0.861	0.849	0.835

The outcome is remarkably similar to that of the slump test. The compacting factor ratio with the greatest value is 0. 91, while the lowest value is 0. 835. For 0 percent MK and mp to 20%, the average compacting factor ratio is 0. 87. In these batches, handling and compacting the new concrete is not an issue. We may deduce from the results that the workability is decreasing as the amount of metakaolin and marble powder utilised increases.

4.3. Compressive strength results:

Table 8. Compressive strength values

S.No	No. of Days	Conventional Concrete	MK(5%)+ MP(5%)	MK(10%)+ MP(10%)	MK(15%)+ MP(15%)	MK(20%)+ MP(20%)
1	7	21.26	22.63	25.83	23.31	19.27
2	14	30.89	32.08	37.16	32.74	24.04
3	28	33.67	35.34	41.28	34.52	26.19



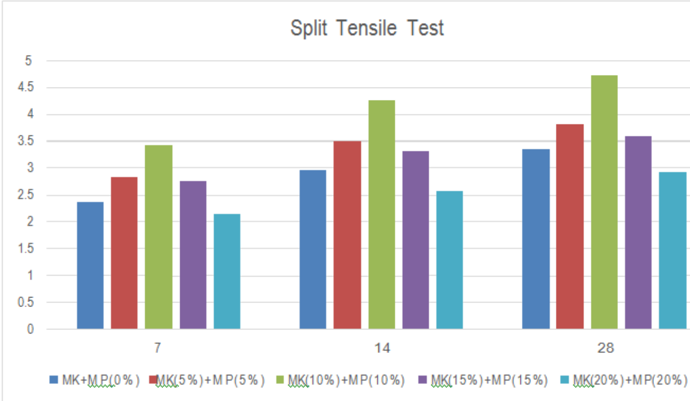
Graph 1. Comparison of Compressive strength of concrete

Result: From the graph, it can be observed that replacing the concrete with 10% Metakaolin and 10% of the marble dust has resulted in a maximum strength of 41.28 KN/M².

4.4. Split Tensile strength results:

Table 9. Split Tensile strength values

S.No	No. of Days	Conventional concrete	MK(5%) +MP(5%)	MK(10%) +MP(10%)	MK(15%) +MP(15%)	MK(20%) +MP(20%)
1	7	2.36	2.84	3.42	2.77	2.14
2	14	2.97	3.49	4.26	3.32	2.58
3	28	3.35	3.82	4.73	3.59	2.93



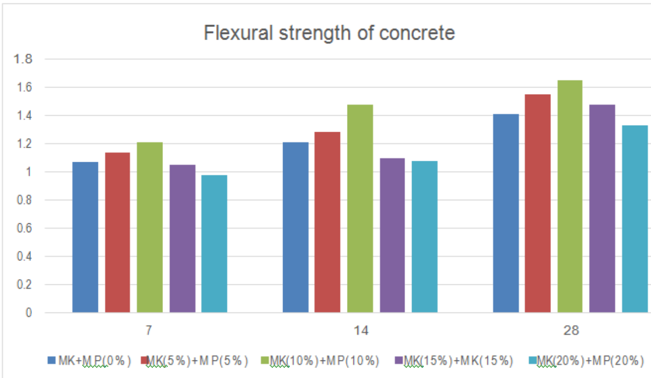
Graph 2. Comparison of Split Tensile strength of concrete

Result: The graph shows that replacing the concrete with 10% Metakaolin and 10% of the marble dust has resulted in a maximum strength of 4.73 KN/M².

4.5. Flexural strength results:

Table 9. Flexural Strength values

S.No	No. of Days	Conventional Concrete	MK(5%) +MP (5%)	MK(10%) +MP(10%)	MK(15%) +MP(15%)	MK(20%) +MP(20%)
1	7	1.07	1.14	1.21	1.05	0.98
2	14	1.21	1.28	1.48	1.10	1.08
3	28	1.41	1.55	1.65	1.48	1.33



Graph 3. Comparison of Flexural strength of concrete

Result: The graph shows that replacing the concrete with 10% Metakaolin and 10% of the marble dust has resulted in a maximum strength of 1.65 KN/M².

5. CONCLUSIONS:

1. According to the findings of the tests, metakaolin and marble dust can be used to partially replace concrete.
2. Concrete has a higher compressive strength when metakaolin and marble dust are replaced by 10%

+ 10%. The highest strength given is 41.28 KN/M^2.

3. Concrete's split tensile strength Concrete has higher cylinder strength when metakaolin and marble dust are replaced by 10% + 10%. 4.73 KN/M^2 is the maximum strength.
4. The maximum strength of 4.73 KN/M^2 was achieved by replacing the flexural strength of concrete with Metakaolin and Marble dust (10% + 10%).
5. The workability of concrete is also deteriorating as the ratio of metakaolin and marble dust increases.
6. Concrete's strength and durability are improving.
7. Eco-friendly by lowering CO2 emissions

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