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A Review on Replacement of Sand with Marble Dust and Cement with Fly Ash

Prof. Gajanan Potbhare⁽¹⁾, Prof. Natish Sayyed⁽²⁾, Amaan Pathan⁽³⁾, Siddhant Kalsait⁽⁴⁾, Piyush Patil⁽⁵⁾,
Piyush Chaudhari⁽⁶⁾, Aryan Jangam⁽⁷⁾, Atharva Nimbalkar⁽⁸⁾, Sanket Jangitwar⁽⁹⁾

Principal, NIT Polytechnic College, Nagpur, India⁽¹⁾

Guide & HOD, Department of Civil Engineering, NIT Polytechnic College, Nagpur, India⁽²⁾

Diploma Student, Department of Civil Engineering, NIT Polytechnic College, Nagpur, India^(3,4,5,6,7,8,9)

ABSTRACT: This study addressed a major part of concrete mix design as a quality control measure for concrete manufacturing under the Indian Standard Code IS: 10262-1982. It is intended to emphasize the relevance of planned concrete in concrete production as opposed to regular ratio-analyzed concrete for any civil/structural concrete construction. It also includes a complete laboratory test analysis to determine the physical and geotechnical properties of the materials required for the mix design in order to obtain the required data for the design procedure, based on the parent material types and location, as well as the specific density of the designed concrete, which will be suitable, adaptable, durable, economical, workable, and generally safe for the structural design objective of the weather condition in any specified location. The design included concrete grade 20N/mm² and was intended to achieve the specified strength grade after 7 days, 14 days, and 28 days of curing, with water as the minimum strength. The designs were created by replacing marble dust with sand and partially replacing fly ash with cement at various percentages, with marble dust replaced by fine aggregate at 10%, 20%, 30%, and 40% and project fly ash replaced by cement at 10%, 15%, 20%, and 25%. It was also thought important that all classes of concrete constructed for attain 65% strength after seven days of water curing. The individual outcomes of the design mix were sufficiently given, demonstrating that mix design of concrete prior to production as a measure of quality control of concrete work is critical in any civil project, whether for the government or people. Quality control should be applied to prevent structural failure.

I. INTRODUCTION

Millions of tons of waste materials are generated as a result of industrialization, and numerous research have been conducted on the protection of natural resources, prevention of environmental degradation, and contribution to the economy through the use of waste materials. The world requires environmentally friendly construction materials. Leaving waste items in the environment directly can lead to environmental problems. As a result, the repurposing of waste materials has received increased emphasis. Waste can be used to make new goods or as admixtures to increase the efficiency of natural resources while protecting the environment from waste deposits. This paper investigates the effect of employing marble dust and fly ash as partial replacements for sand and cement on concrete grades (M20). The key variable considered is the percentage of marble dust used as a partial replacement for sand in concrete mixtures. Marble powder is one of the materials that has an impact on the environment and causes health issues. It is formed during the sawing, shaping, and polishing processes. The marble stone industry produces both solid waste and stone slurry.

In civil engineering, 'cement' is crucial since it is difficult to build any durable infrastructure without it. We might claim that everything is incomplete without 'cement' because building is a fast growing industry with new inventions and ideas. For a long time, the cement industry has used a variety of Pozzolanic ingredients to improve cement qualities. or have an artificial origin (silica fume, fly ash, blast furnace slag, etc.). The use of additional cementitious ingredients for economic, technical, and environmental reasons has become quite widespread in modern concrete building. Concrete mix design refers to the process of selecting suitable concrete materials and determining their relative proportions in order to make concrete with the required strength, durability, and workability as economically as possible. The proportioning of concrete ingredients is determined by the performance requirements of concrete in two states: pliable and hardened. Plastic concrete that is not workable cannot be properly laid or compacted. Therefore, the property of workability becomes vitally important. The compressive strength of hardened concrete, which is widely regarded as an indicator of its other attributes, is determined by a variety of factors, including the quality and quantity of cement, water, and aggregates used; batching and mixing; placing, compaction, and curing.

From a technical standpoint, the rich mixes may produce significant shrinkage and cracking in structural concrete, as well as the evolution of high heat of hydration in mass concrete, which may induce cracking.

If you are planning a civil project that incorporates the use of concrete as a structural member, you must test all of the materials required for the concrete to evaluate their physical qualities. These include water, fine aggregate (sand), coarse aggregate, cement, chemicals, reinforcement, and soil, which are used to establish the project location's bearing capability. The physical parameters acquired will be used to determine all design concerns for the concrete mix design. These will help to prevent failure in the design of the overall structure and the concrete mix required for the project. If this project is well-supervised, it will meet its design age. Every project requires a qualified quality control engineer. Concrete holds a unique position among modern construction materials. Concrete is a material used in building construction that is made up of a hard, chemically inert particulate substance known as an aggregate (typically sand and gravel) bonded by cement and water. The mix design for concrete M20 grade follows the Indian Standard Code IS 10262-1982. Fly ash is widely used as a partial replacement for cement. However, despite the addition of fly ash in concrete provides several benefits, such inclusion produces a significant drop in early strength due to the comparatively slow hydration of fly ash. Nevertheless, fly ash improves the workability of concrete. Quarry dust has been recommended as an alternative to river sand that provides additional benefits to concrete. Quarry dust is known to increase the strength of concrete compared to concrete manufactured with equivalent amounts of river sand, but also reduces concrete's workability. In this paper, fly ash is substituted by cement at 10%, 15%, 20%, and 25%. Marble dust is replaced by fine aggregate by 10%, 20%, 30%, 40%, and 50%.

II. LITERATURE REVIEW

Hassan A. Mohamadien (2016) The feasibility of employing marble powder and silica fume (S.F) independently as partial replacements for cement on mortar was investigated, and the percentage of partial cement replacement with both marble powder and silica fume was calculated. Four types of mortar mixtures with the same workability, cement-to-sand ratio of 1:3, and water-to-cementitious materials ratio of 0.4 are made by mixing marble powder and silica fume separately.

S.K. Agarwal (2018) employs fly ash, slag, silica fume, and marble dust as cement replacements and investigates their effect on the compressive strength and cost-effectiveness of low w/c ratio superplasticizer Portland cement mortars. Cement mortars (1:3 and 1:6) with different quantities of industrial waste were constructed to have a flow rate of $110 \pm 5\%$. The compressive strength of mortars with and without superplasticizer was measured at 1, 3, 7, 28, and 180 days, and their cost-effectiveness was evaluated. It has been discovered that replacing various industrial wastes (up to 20%) enhanced the compressive strength of mortar (1:3), with the exception of marble dust, where the strength is greater at 28 days but decreases by 10% at 180 days. In the presence of a superplasticizer, the mortar's maximal compressive strength was achieved by replacing 10% of the cement with silica fume.

V. M. Shelke The influence of partial cement replacement with marble powder and silica fume was investigated and compared to the compressive strength of standard M30 concrete. Thus, determining the percentage of marble powder and silica fume substituted in concrete to achieve the highest concrete strength. In their investigation, a series of compression tests were performed on cubical and cylindrical specimens using a modified test method that provided the complete compressive strength, using silica fume of constant 8% with and without marble powder of volume fractions 0, 8, 12, and 16% on Ordinary Portland cement concrete. The study's findings reveal that adding marble powder reduces the compressive strength of concrete slightly, whereas substituting silica fume boosts compressive strength. The optimal compressive strength of the cube and cylinder is achieved by replacing OPC cement with 8% silica fume and 8% marble powder in the concrete.

Mehta And Monteiro (1997) Supplementary materials such as fly ash, slag, and silica fume, when used in concrete production, improve several properties such as strength and permeability, reducing the ingress of water and other harmful salt solutions and, in many cases, lowering the overall production cost. The use of mineral admixtures improves strength because of the pozzolanic reaction, which normally begins after seven days and generates increases in the amount of C-S-H gel, which is believed to be the strength-implementing component in concrete. Studies have also demonstrated that a combination of fly ash and slag improves the strength of concrete at any age, similar to the addition of silica fume (Tan and Pu 1998). The usage of supplemental materials has gained popularity in the building industry because it has the potential to solve durability issues. Plane concrete mixtures, when utilized in mass concrete construction such as dams, produce extremely high hydration temperatures, resulting in difficulties such as thermal



cracking. The use of materials like fly ash or slag offers the possibility of reducing a temperature rise almost in direct proportion to the amount of replaced durability to chemical attacks is improves the reuse of most fly ashes and slags mainly due to the pore refinement of concrete met with such materials experiments have shown that cement-based containing 10-30% low calcium fly ash causes significant pore refinement in 28-90 days curing period.

Gebler and Klieger (1986) demonstrated that increasing the compressive strength of concrete is critical for improving its scaling resistance. The average compressive strength of three concrete mixtures (cured at 4.4 °C) including Class F fly ash was reported to be 3500psi, 4460psi, and 4910psi. Class C fly ash and ordinary cement, respectively. They found that when compressive strength increases, deicer scaling resistances generally improve. The cementitious material in the Class C and Class F mixes was 517lb/yd³, whereas the simple cement mixtures were 474lb/yd³. There are additional recommendations that a minimum cementitious material of 564lb/yd³ and a maximum water to cementitious materials ratio of 0.45 should be chosen for satisfactory performance of concrete exposed to deicer salts (Kosmatka 2002).

III. OBSERVATION

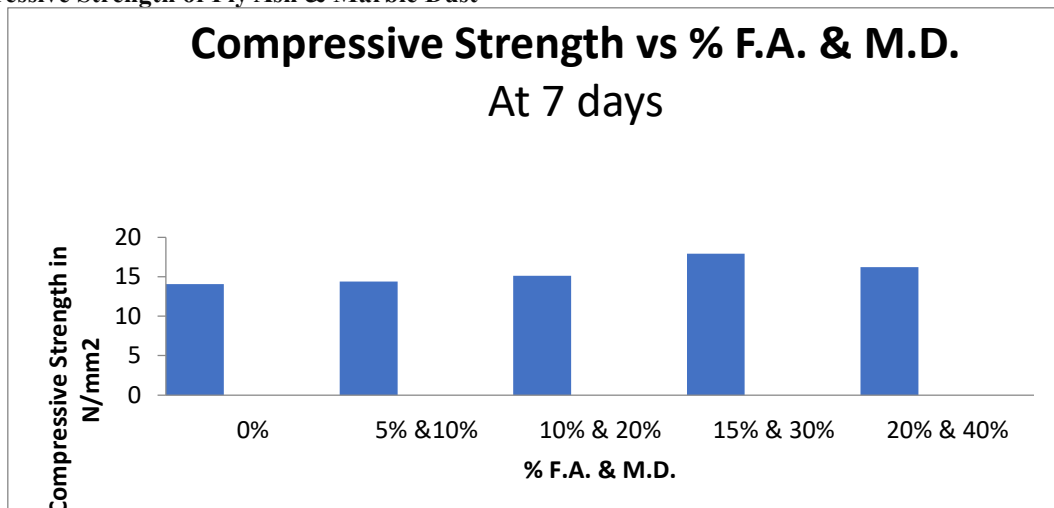
Concrete mix design refers to the process of selecting appropriate concrete materials and determining their relative proportions with the goal of producing concrete with the needed strength, durability, and workability as economically as possible. The proportioning of concrete ingredients is determined by the performance requirements of concrete in two states: pliable and hardened. Plastic concrete that is not workable cannot be properly laid or compacted. Therefore, the property of workability becomes vitally important.

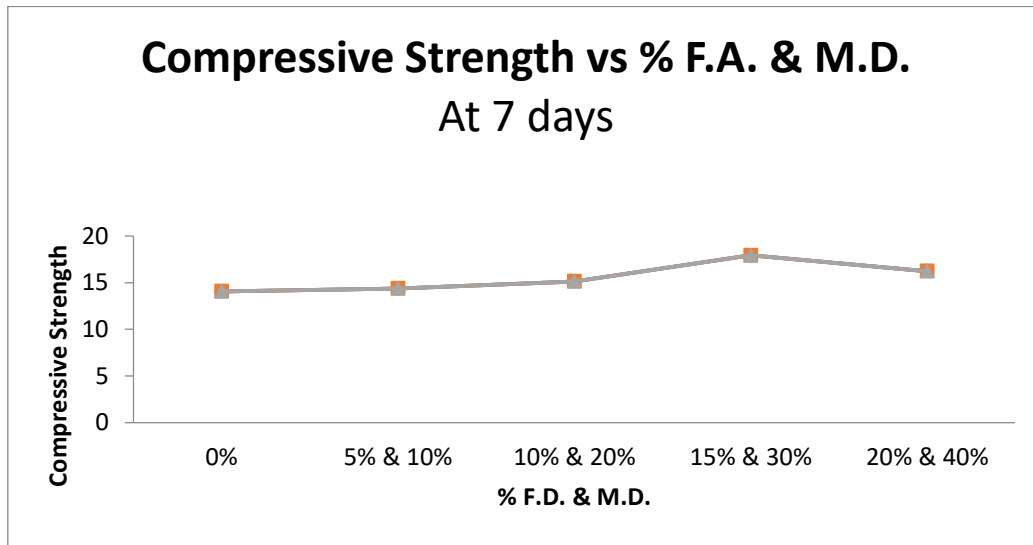
The compressive strength of hardened concrete, which is widely regarded as an indicator of its other attributes, is determined by a variety of factors, including the quality and quantity of cement, water, and aggregates used; batching and mixing; placing, compaction, and curing. The cost of concrete includes the cost of materials, plant, and labor. The variances in material costs result from the fact that cement is several times more expensive than aggregate, hence the goal is to generate the leanest mix feasible. From a technical standpoint, rich mixes may produce significant shrinkage and cracking in structural concrete, as well as the evolution of high heat of hydration in mass concrete, which may cause cracking.

The real cost of concrete is connected to the cost of materials required to provide a minimum mean strength, known as characteristic strength, as stipulated by the structure's designer. This is dependent on the quality control procedures used, but there is little doubt that quality control increases the cost of concrete. The level of quality control is frequently an economic compromise that varies according to the size and type of task. The cost of labour is determined by the workability of the mix; for example, a concrete mix with insufficient workability may result in a high labor cost to achieve a level of compaction with existing equipment.

IV. RESULTS

1. Compressive Strength of Fly Ash & Marble Dust

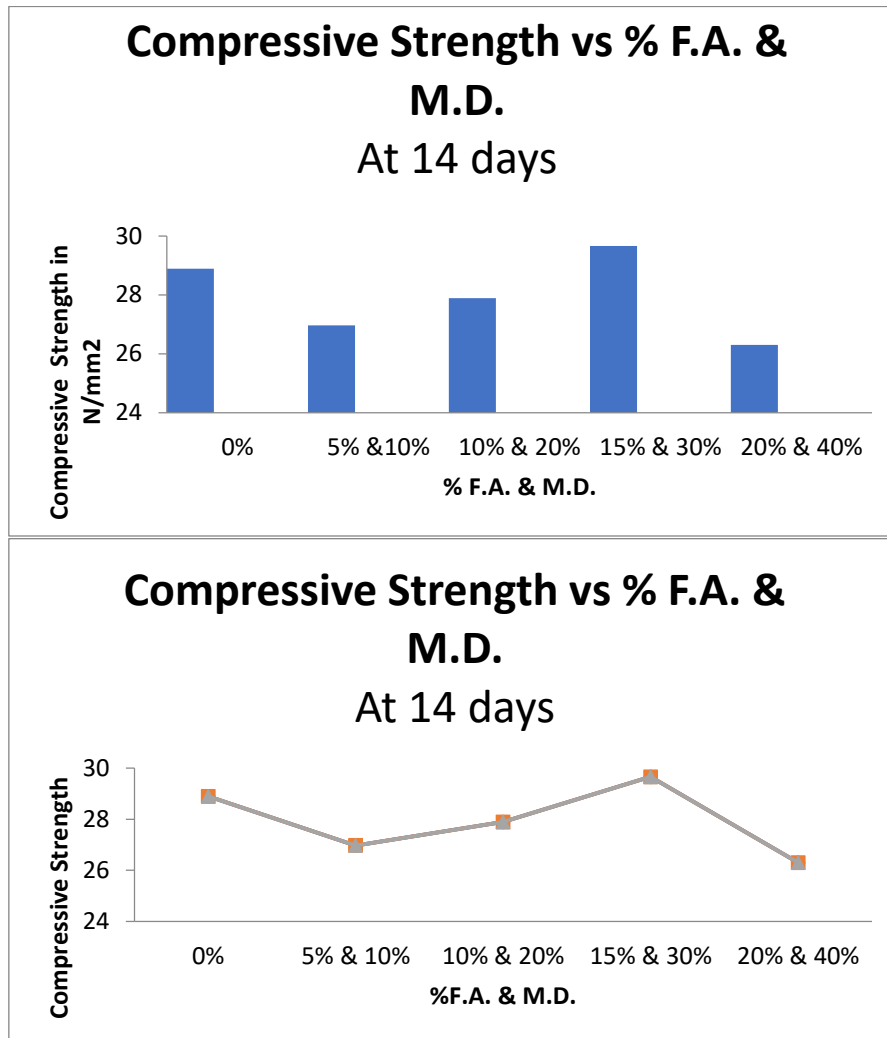




The accompanying graph shows that the maximum compressive strength is reached with 15% fly ash and 30% marble dust. The maximum amount is 15% fly ash and 30% marble dust. As the percentage of fly ash and marble dust increases, the compressive strength steadily decreases.

2. Compressive Strength for 14 Days

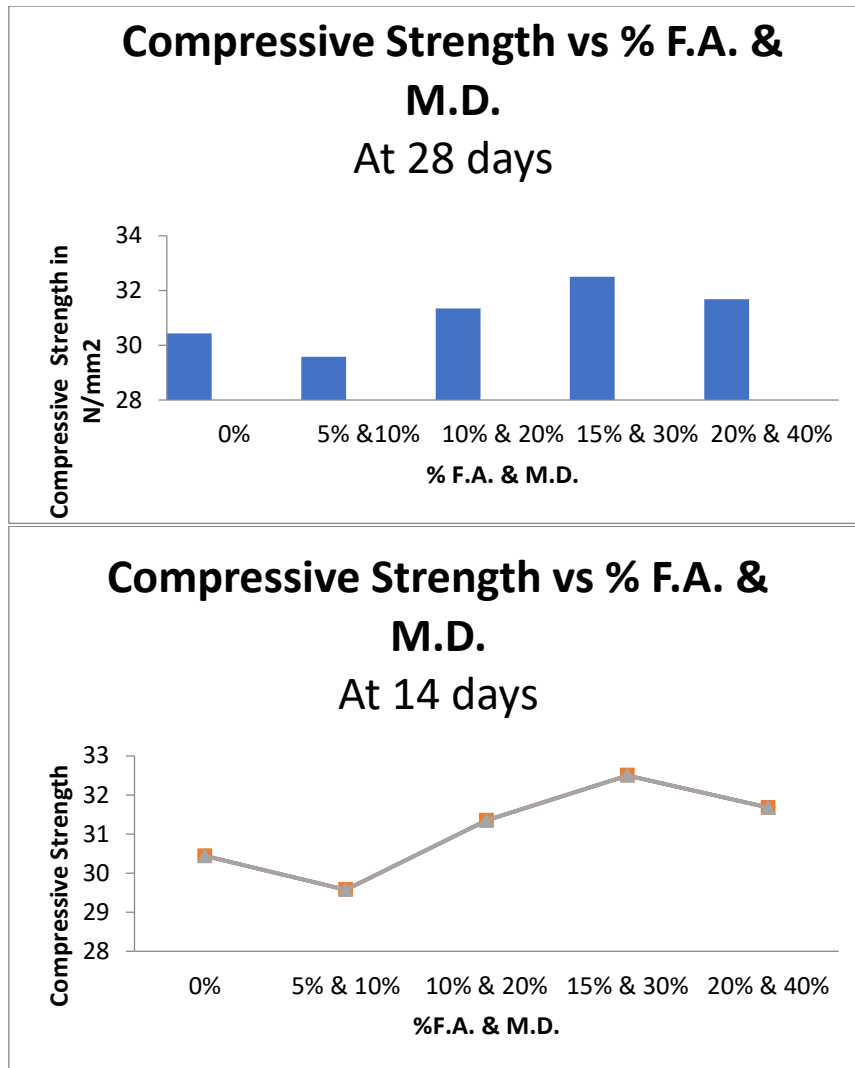
%Fly Ash	% Marble Dust	Sample 1 (N/mm²)	Sample 2 (N/mm²)	Sample 3 (N/mm²)	Avg. Strength (N/mm²)
0%	0%	29.78	27.55	29.33	28.89
5%	10%	24.88	29.78	26.25	26.97
10%	20%	26	29.33	28.35	27.89
15%	30%	30.44	29	29.54	29.66
20%	40%	25.95	26.95	26	26.30



The graph above shows that the maximum composite strength is reached with 15% fly ash and 30% marble dust. The maximum amount is 15% fly ash and 30% marble dust. The optimal percentage of fly ash and marble dust is reached, and as the percentage of fly ash and marble dust increases, the composite strength steadily decreases.

3. Compressive Strength for 28 Days

%Fly Ash	% Marble Dust	Sample 1 (N/mm ²)	Sample 2 (N/mm ²)	Sample 3 (N/mm ²)	Avg. Strength (N/mm ²)
0%	0%	30.22	29.11	32	30.44
5%	10%	29.86	28.46	30.42	29.58
10%	20%	30.25	31.26	32.56	31.35
15%	30%	31.25	31.58	33.56	32.50
20%	40%	30.54	31.85	32.65	31.68



The accompanying graph shows that the maximum comp. strength is reached with 15% fly ash and 30% marble dust. The maximum amount is 15% fly ash and 30% marble dust. The optimal percentage of fly ash and marble dust is reached, and as the percentage of fly ash and marble dust increases, the composite strength steadily decreases.

V. CONCLUSION

Marble dust and fly ash improve the mechanical characteristics and durability of partially rebuilt concrete. The use of 15% fly ash and 30% marble dust in cement concrete to increase compressive strength. The incorporation of marble dust and fly ash in the concrete may result in denser matrices, boosting resistance to water intrusion, which is one of the most important factors contributing to concrete deterioration. The use of fly ash and marble dust results in a denser composition that fills even micro-voids, increasing concrete's impermeability. Better impermeability may result in improved crack and corrosion resistance, as well as reduced susceptibility to chemical assault. Marble dust and fly ash concrete exhibits significantly better qualities than regular cement concrete. It is preferable to utilize marble dust and fly ash in high-performance concrete despite the higher expense, given the increased strength and durability that marble dust and fly ash concrete provides. Taking into account environmental factors, energy conservation, and economics, reactive ash manufacturing can result in excellent technological benefits for the community as a whole. Furthermore, the future looks promising. There is an increasing need for fine amorphous fly ash in the manufacture of specific cement and concrete mixtures. So it should be considered for improved production.



VI. FUTURE SCOPE

Fly ash can be used as an additive to increase the strength of concrete while partially replacing cement. Partial substitution of cement with fly ash reduces mortar density, which lessens the structure's dead weight. Using fly ash helps to prevent environmental contamination caused by the disposal of fly ash and marble dust. Cement is expensive and rare, therefore partial substitution with fly ash is both cost-effective and environmentally friendly. Fine aggregate is rarely obtainable in the requisite quality, thus the use of marble dust powder aids in its improvement.

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